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Sediment Impact Assessment for Navigation Channel Maintenance, Alabama River, Alabama, and Apalachicola River, Florida

by Dinah N. McComas, Ronald R. Copeland

WES

Prepared for U.S. Army Engineer District, Mobile

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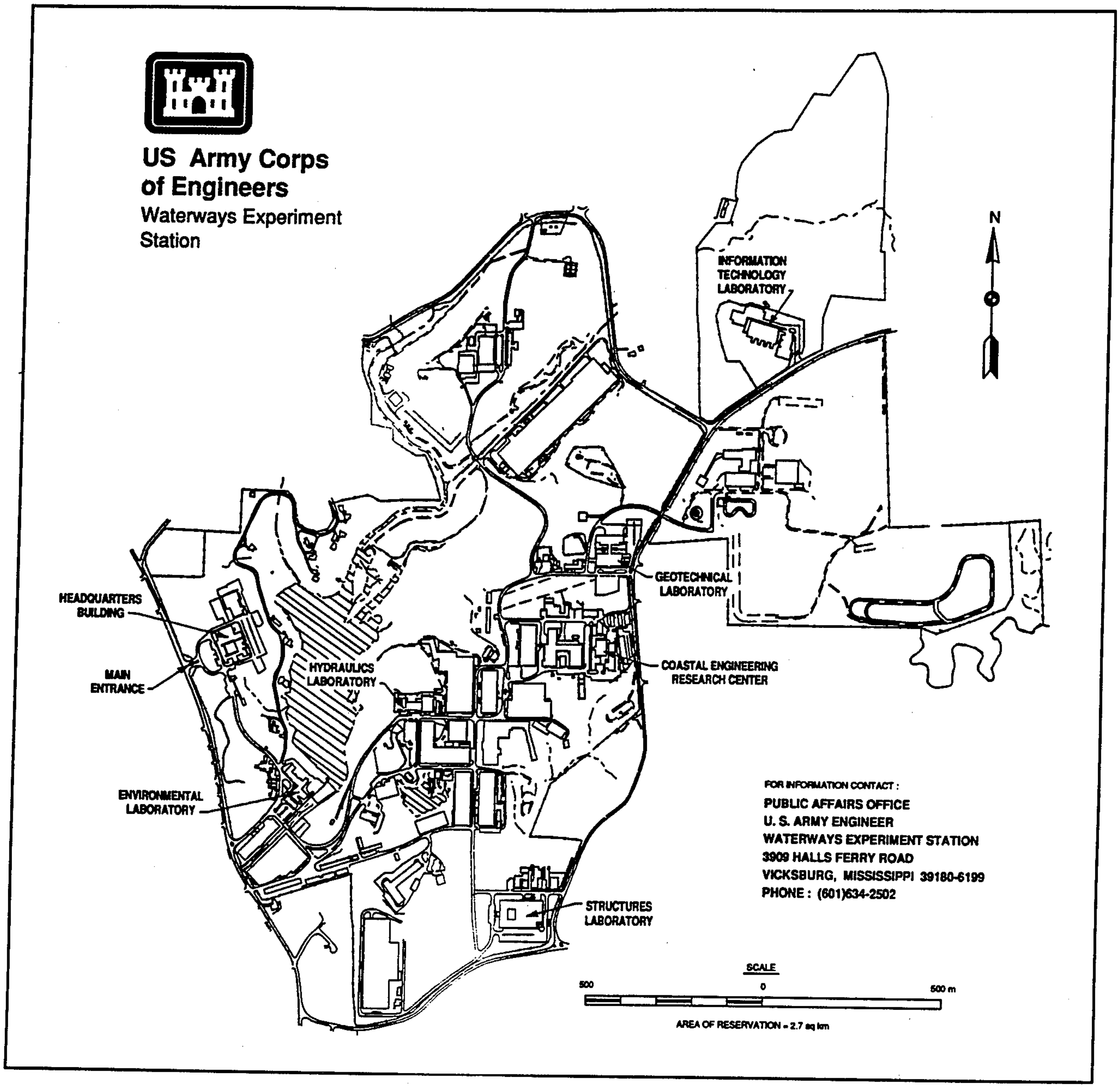

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Contents

Preface

These sediment impact assessments for the Alabama River, from its confluence with the Tombigbee River to Claiborne Lock and Dam, and for the Apalachicola River, from Apalachicola Bay to Jim Woodruff Lock and Dam, were conducted at the request of U.S. Army Engineer District, Mobile. The work was performed at the U.S. Army Engineer Waterways Experiment Station (WES).

This investigation was conducted during the period April 1995 to February 1996 in the Hydraulics Laboratory of the U.S. Army Engineer Waterways Experiment Station (WES), under the direction of Mr. Richard A. Sager, Acting Director, Hydraulics Laboratory; Mr. Robert F. Athow, Acting Assistant Director, Hydraulics Laboratory; Mr. William H. McAnally, Chief of the Waterways and Estuaries Division, and Mr. Michael J. Trawle, Chief of the Rivers and Streams Branch, Waterways and Estuaries Division. The project engineer for this study was Dr. Ronald R. Copeland, and technical assistance was provided by Mrs. Dinah N. McComas, both of the Rivers and Streams Branch. This report was prepared by Mrs. McComas and Dr. Copeland.

Mr. Bill Stubblefield, Mobile District, served as coordinating engineer, providing required data and review.

During the publication of this report, Dr. Robert W. Whalin was Technical Director of WES. Commander of WES was COL Bruce K. Howard, EN.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
cubic yards	0.7645549	cubic meters
feet	0.3048	meters
miles (U.S. statute)	1.609347	kilometers
pounds (force) per square foot	47.88026	pascals
tons (2,000 pounds, mass)	907.1847	kilograms

1 Introduction

This report documents two sediment impact assessments completed for the Mobile District, Corps of Engineers. The two rivers under investigation are the Alabama, in Alabama, and the Apalachicola, in Florida. Each river is facing proposed navigation channel design changes due to proposed changes in the minimum release from upstream dams. The analyses for the two rivers were requested at the same time and are similar in approach.

The purpose of these sediment impact assessments is to identify and roughly quantify the magnitude of sediment problems associated with alternative proposed navigation channel designs. The sediment budget approach is generally appropriate for the reconnaissance level planning study.

The relative magnitude of potential dredging requirements for four proposed channel modification plans on the Alabama River and for three proposed channel modification plans on the Apalachicola River were compared using a sediment budget approach. The study reach on the Alabama River extended between its confluence with the Tombigbee River and Claiborne Lock and Dam, Figure 1. Sediment transport rating curves were calculated, for each plan, at five typical reaches. Another seven reaches, shorter in length, were also compared. The study reach on the Apalachicola River extended between Apalachicola Bay and Jim Woodruff Lock and Dam (Figure 2). Sediment transport rating curves were calculated, for each plan, at five typical dredging reaches. Average annual flow duration curves for both rivers were then numerically integrated with the sediment transport rating curves to calculate average annual sediment transport capacity for each plan in each of the designated reaches.

2 Alabama River

Hydraulic Parameters

The channel geometries for the four alternative channel modifications were developed by the Mobile District and supplied to WES in the form of HEC-2 backwater models. The models extended from the confluence of the Alabama and Tombigbee Rivers, at navigation mile (NM) 0.0, to Claiborne Lock and Dam at NM 72.4, as shown in Figure 1. The four models represent conditions in which a nine-ft-deep navigation channel is maintained for low flow discharges of 9,500; 7,500; 6,600; and 5,000 cfs. The existing channel is maintained for a low flow of 7,500 cfs, and this alternative was used as the baseline point of comparison. WES used the HEC-2 models to develop discharge rating curves over the range of discharges included in the average annual flow duration curve, which ranged between 3,000 and 320,000 cfs. No downstream rating curve was available so a downstream water-surface elevation of 0.001 feet NGVD was assumed for all discharges. This rendered the downstream eight miles of the model unrepresentative at high discharges. The M-2 profile appeared to have normalized after eight miles. It was also necessary to assume that overbank conveyance was negligible, because the HEC-2 models did not include all the available overbank areas. The reported bankfull discharge is 30,000 cfs[1]. The reasonableness of these assumptions was checked by comparing the calculated rating curve to measured rating curves at three stations in the study reach. The comparisons are shown in Figures 3-5. These curves demonstrate that the HEC-2 model produces rating curves suitable for the scope of this evaluation despite the limitations imposed by the assumptions.

Five reaches were chosen as typical reaches for the sediment budget evaluation. These are reaches where dredging problems have occurred in the past. Dredging records between 1981 and 1994 were used in the selection process. The study reaches are listed in the following tabulation.

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[1] U.S. Army Engineer District, Mobile. (1967). "Design Memorandum No. 2, Channel Improvement, Alabama River, Alabama," Mobile, AL.

The reach locations are marked on Figures 6-9, which also show the calculated water surface elevation profiles (from HEC-2 for the 7,500 cfs geometry) for selected discharges, and the thalweg. Average hydraulic parameters for each reach were calculated from HEC-2 output using the SAM hydraulic design package. Plots of channel velocity and average shear stress for the 7,500 cfs geometry are shown in Figures 10-17. In Figure 14 the first eight miles of the model are not included in the plot because calculated shear stresses were excessive at the downstream boundary due to the uncertainty associated with the assumed starting water-surface elevation. Inclusion of these unrepresentative calculated values would have required an extended ordinate.

Reach No.	River Miles
1	19.0 -24.0
2	33.5 - 37.0
3	40.5 - 43.8
4	57.0 - 60.5
5	66.0 - 70.0

Sediment Transport

Bed material samples were collected from the Alabama River in 1985 and 1994. The 1985 samples were collected from seven sand bars between NM 16 and 36, using a scoop. The gradations from these samples were not used in this study since more recent, more complete data were available. Because of this, and the fact that the 1985 data are published elsewhere[1], the 1985 bed gradations are not given in this report. The 1994 samples were collected at 11 locations between NM 5 and 70, using a standard USBM-54. Samples were collected from at least three locations at each station in 1994. Lateral variation was significant at some cross-sections and negligible at others. Gradations for all eleven stations are plotted in Figures 18-28. There was no obvious longitudinal trend in bed material gradation except for the upstream-most stations at NM 68 and 69.8, which are just downstream from Claiborne Lock and Dam. Longitudinal variation in the average median grain size of the 1994 samples is shown in Figure 29. For this sediment budget analysis, the average of all 1994 samples was used for the bed-material gradation. The average gradation and the range of data are shown in Figure 30.

Measured suspended sand data from the USGS gaging station, Alabama River at Claiborne, was used to select a sediment transport equation for the sediment budget analysis. The gage is located on the Highway 84 bridge at NM 66.8. Suspended sand measurements were collected between 1973 and 1980 by the USGS and between 1980 and 1981 by the Mobile District. These

[1] Simons, Li and Associates. (1982). "A preliminary study of the hydrologic, hydraulic, geomorphic, and sediment transport characteristics in the Lower Black Warrior and Tombigbee River System," for the U.S. Army, Engineer District, Mobile, Mobile, AL.

data were used in a previous study[1] to develop least-squares-fitted regression lines for both the wash load and the bed material load, Figure 31. The USGS continues to collect suspended sediment data at the Claiborne bridge gage.

The SAM hydraulic design package was used to calculate sediment transport in the vicinity of the Claiborne bridge (between NM 68.5 and 71.3). Average hydraulic parameters for the sediment transport calculations were determined from the HEC-2 backwater model for the 7,500 cfs low flow channel. Calculated results for several transport equations are compared to the measured data in figure 32. The best results over the total range of water discharges were obtained with the Toffaleti and Yang equations. The Toffaleti equation slightly over predicts, and the Yang equation slightly under predicts sediment transport capacity. These two equations were used to predict a high and low estimate of sediment transport capacity for each condition in this sediment budget analysis.

Hydrology

The average annual flow duration curve was developed from 63 years of combined mean daily flow records, 1930-1993, from the Alabama River at Claiborne and the Alabama River at Claiborne Lock and Dam gages. These data were obtained from USGS published records. The flow duration curve is shown in Figure 33. The maximum flow of record at the gages -- 322,000 cfs -- was added to the flow duration curve for the sediment transport capacity calculation. This discharge was assigned a zero percent exceedance. The sediment transport capacity calculations demonstrated that sediment transport is negligible at discharges below 10,000 cfs. Therefore, using a single flow duration curve for all alternatives is deemed appropriate for this level of study.

Sediment Transport Capacity

Average annual sediment transport capacity was calculated using the SAM hydraulic design package for each channel modification plan for each of the five reaches. This calculation is an integration of the sediment transport rating curve and the average annual flow duration curve. Calculated capacities were determined by using both the Toffaleti and Yang functions. The results are given in Table 1.

For the 6,600 and 5,000 cfs channels the tabulations indicate a decrease in sediment transport capacity. This decrease is attributed to the additional cross-sectional area created by additional dredging requirements for the lower minimum-discharge channels. Since deposition normally occurs in all these

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[1] Simons, Li and Associates, *op. cit.*

Table 1
Comparison of Calculated Annual Sediment Transport Capacity, Long Reaches, Alabama River between Claiborne Lock and Dam and the Tombigbee River

Reach, NM	Navigation Channel Geometry						
	9,500 cfs		7,500 cfs	6,600 cfs		5,000 cfs	
	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel per year	Existing 1000 cubic yards per year	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel per year	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel per year
Toffaleti Function							
19.0 - 24.0	521	100.2	520	520	100.0	518	99.6
33.5 - 37.0	599	99.8	600	597	99.5	585	97.5
40.5 - 43.8	324	98.4	329	323	98.3	320	97.3
57.0 - 60.5	738	100.1	737	728	97.8	717	97.3
66.0 - 70.0	775	100.0	775	766	98.8	736	95.0
Yang Function							
19.0 - 24.0	282	100.0	282	281	99.6	280	99.3
33.5 - 37.0	252	100.0	252	251	99.6	246	97.6
40.5 - 43.8	109	99.1	110	108	98.2	107	97.3
57.0 - 60.5	286	100.0	286	281	98.2	274	95.8
66.0 - 70.0	305	100.3	304	299	98.4	283	93.1

reaches, the difference in calculated sediment transport capacities provides an indicator of relative differences in rates of deposition.

A decrease in sediment transport capacity between 0.0 and 2.2 percent was calculated for the 6,600 cfs minimum flow channel, and between 0.4 and 6.9 percent for the 5,000 cfs minimum flow channel. The average calculated decrease in sediment transport capacity for the 6,600 cfs channel was 1.2 percent. The average calculated decrease in sediment transport capacity for the 5,000 cfs channel was 3.0 percent. These decreases in sediment transport capacity should lead to an increase in the annual deposition and dredging.

However, for the 9,500 cfs channel the tabulations indicate mixed effects. In some reaches there is a slight increase in sediment transport capacity for this channel, but there are also reaches which show a decrease in sediment transport capacity. The increase in capacity was between 0.0 and 0.3 percent, while in areas evidencing a decrease in sediment capacity compared to the 7,500 cfs channel the decrease was between 0.0 and 1.6 percent. The average calculated change in sediment transport capacity for this channel geometry is a decrease of 0.2 percent. Within the degree of accuracy that can be expected

from the applied methodology, it may be concluded that differences in rates of deposition with the 7,500 and 9,500 cfs channels are negligible.

Sediment transport capacity quantities were higher when the Toffaleti function was used, but percentage differences between the two sediment transport functions were insignificant. However, the calculated sediment transport capacity is significantly different for the different reaches. This demonstrates the variability of sediment transport capacity through the 72-mile study reach. Aggradation or degradation in specific reaches of the river will depend not only on localized hydraulic and sediment characteristics, but also on upstream conditions.

Additional Reach Analyses

The five reaches originally selected for analysis included both pools and crossings. In order to determine if significant differences were averaged out because the reaches chosen were too long, seven shorter reaches, composed of single crossings, were chosen for analysis. Six of these new reaches are contained within the original reaches, and all were selected in reaches where dredging had occurred between 1981 to 1994. These study reaches are listed in the folllowing tabulation.

Reach No.	River Miles
11	2.9 - 22.5
01	30.7 - 31.7
21	34.0 - 35.0
31	40.5 - 41.4
32	42.7 - 43.9
41	57.4 - 58.6
51	66.4 - 67.6

The reach locations are marked on Figures 6-9. These study reaches were analyzed using the same methodology as the first group of study reaches.

Average annual sediment transport capacities for these seven shorter reaches were calculated using the SAM hydraulic design package for each channel modification plan. Calculated capacities were determined by using both the Toffaleti and the Yang functions. The results are given in Table 2.

These tabulations are similar to the tabulations using the longer reaches. Differences in sediment transport capacity are of the same order of magnitude as calculated using the longer reaches. The average calculated decrease in sediment transport capacity for the 6,600 cfs channel was 1.2 percent. The average calculated decrease in sediment transport capacity for the 5,000 cfs

Table 2
Comparison of Calculated Annual Sediment Transport Capacity, Short Reaches, Alabama River between Claiborne Lock and Dam and the Tombigbee River

	Navigation Channel Geometry						
	9,500 cfs		7,500 cfs	6,600 cfs		5,000 cfs	
Reach, NM	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel	Existing 1000 cubic yards per year	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel	1000 cubic yards per year	Percent of Capacity in 7,500-cfs Channel
Toffaleti Funtion							
21.9 - 22.5	526	101.2	520	519	99.8	516	99.2
30.7 - 31.7	423	102.9	411	407	99.0	399	97.1
33.7 - 35.0	702	100.0	702	703	100.0	691	98.5
40.5 - 41.4	288	100.7	286	280	97.9	274	95.8
42.7 - 43.9	443	99.3	446	440	98.6	435	97.5
57.4 - 58.6	707	98.7	716	710	99.2	692	96.6
66.4 - 67.6	818	100.4	815	806	98.9	782	96.0
Yang Function							
21.9 - 22.5	309	101.3	305	304	99.7	302	99.0
30.7 - 31.7	199	103.6	192	189	98.4	183	95.3
33.7 - 35.0	285	99.7	286	286	100.0	279	97.6
40.5 - 41.4	94	100.0	94	91	96.8	88	93.6
42.7 - 43.9	172	98.9	174	171	98.3	168	96.6
57.4 - 58.6	276	98.2	281	278	98.9	267	95.0
66.4 - 67.6	330	100.3	329	323	98.2	310	94.2

channel was 3.4 percent. For the 9,500 cfs channel, the average calculated change in the sediment transport capacity was a .04 percent increase.

Alabama River Summary

The sediment budget analysis demonstrates that the differences in sediment transport capacity for the 6,600 and 5,000 cfs channels will be less than seven percent. The average calculated difference for all reaches was 1.2 percent for the 6,600 cfs channel and 3.2 percent for the 5,000 cfs channel. Differences in sediment transport capacity between the 7,500 cfs channel and the 9,500 cfs channel are negligible. The sediment budget analysis also demonstrated the significant differences in sediment transport capacity for different reaches of

the river. It is these differences that will most likely translate to dredging problems along the navigation channel.

3 Apalachicola River

Hydraulic Parameters

The channel geometries for the three alternative channel modifications were developed by the Mobile District and supplied to WES in the form of HEC-2 backwater models. The models extended from navigation mile (NM) 6.0, near Apalachicola Bay, to Jim Woodruff Lock and Dam at NM 106, Figure 2. The three models represent conditions where a nine-ft-deep navigation channel is maintained for minimum flow discharges of 9,300; 11,000; and 13,000 cfs. The HEC-2 models provided by the Mobile District did not include overbank geometry. The models included estimates for flow diversion percentages into bypass channels for discharges of 9,300; 11,000; and 13,000 cfs.

The discharge range in the Districts's HEC-2 models had to be expanded in order to determine hydraulic parameters for the full range of the average annual flow duration curve (4,7000 - 185,000 cfs). The model for the existing minimum flow channel of 9,300 cfs was used as the base model to estimate channel discharges for the sediment budget analysis. The same roughness coefficients determined by the District were used. The downstream water surface elevation was assumed to be mean sea level for the full range of discharges. Bypass flow diversion percentages determined by the Mobile District were used in this study. Initially, the percentages determined for the 13,000 cfs minimum flow channel were assumed for 13,000 cfs and all discharges greater than 13,000 cfs. The percentage determined by the District for the 9,300 cfs minimum flow channel was used for 9,300 cfs and discharges less than 9,300 cfs. At higher flows a greater percentage of the total discharge is diverted onto the overbanks, and since the model geometry included only the main Apalachicola River channel, it was necessary to estimate the flow percentage in the overbanks over the full range of discharges. A trial and error procedure, in which channel discharges were adjusted, was used to develop calculated water-surface profiles that matched measured stage-discharge rating curves at four gages on the Apalachicola River. These were near Sumatra (NM 20.6), near Wewahitchka (NM 44.2), near Blountstown (NM 78), and at Chattahoochee (NM 106). These rating curves were based on measured stages at the gages and the total discharge at some upstream point where the total discharge could be determined. The comparisons are shown in Figures 34-37. The final model channel discharges

used to reproduce these stage rating curves are shown in Figure 38. These curves demonstrate that the HEC-2 model produces stages and discharges in the Apalachicola River main channel suitable for the scope of this evaluation, despite the limitations of the assumptions. The same longitudinal discharge distribution was used for all three minimum flow channel alternatives.

Five reaches were chosen as typical dredging reaches for the sediment budget evaluation. These are reaches where dredging has been required in the past. Dredging records between 1957 and 1994 were used in the selection process. The study reaches are listed in the following tabulation.

Reach No.	River Miles
1	17.4 - 19.0
2	35.5 - 37.2
3	38.8 - 41.5
4	60.2 - 66.8
5	87.1 - 87.5

The reach locations are marked on Figure 39, which also shows the calculated water surface elevation profiles (from HEC-2 for the 9,300 cfs geometry) for selected discharges, and the thalweg. Plots of channel velocities are shown in Figure 40. Average hydraulic parameters for each reach were calculated from the HEC-2 output using the SAM hydraulic design package.

Sediment Transport

Bed material samples used to define the existing bed gradation were collected from the Apalachicola River in 1987 and 1991. The bed material is coarsest at the upstream end of the study, downstream from Jim Woodruff Dam, and generally becomes finer as the river moves toward Apalachicola Bay. Averages determined for three reaches are shown in Figure 41. The median grain size was 0.40 mm in the reach between NM 3.6 and the lower end of the Chipola Cutoff; 0.45 mm in the reach between the upper end of the Chipola Cutoff and Blountstown; and 0.80 mm in the reach between Blountstown and Chattahoochee. In the two lower reaches only about 5 percent of the bed was gravel, whereas in the upper reach about 30 percent of the bed was gravel. For the sediment budget analysis an average of all bed samples was used to obtain an average gradation for the entire reach. This simplification is deemed appropriate for the comparative evaluation approach used in the sediment budget analysis. The median grain size was 0.48 mm as shown in Figure 42, which displays the average gradation and the envelope of all samples.

Available measured suspended sediment data did not include sufficient particle size distributions, rendering the data inadequate for analysis of bed-material transport. Therefore, the applicability of sediment transport functions could not be demonstrated. In the absence of data, transport functions developed by Toffaleti and Yang, which have been demonstrated to be reliable for the lower reaches of the nearby Alabama River, were used for the

Apalachicola River. In comparisons with measured data from the Alabama River the Toffaleti function was found to slightly over-predict sediment transport rates, and the Yang function was found to slightly under predict sediment transport rates. These functions provide a high and low estimate of sediment transport capacity for the sediment budget analysis.

Hydrology

The flow duration curve was developed from 18 years of data (1974 through 1993) from the Apalachicola River near Blountstown gage. Data from previous years were excluded because of dam construction in the watershed. West Point Lake, which became operative in 1974, is the last reservoir to significantly influence flow duration curves. Data were obtained from USGS published records. The flow duration curve is shown in Figure 43. The maximum flow of record (between 1974 and 1993), which was 185,000 cfs, was added to the flow duration curve for the sediment transport capacity calculation. This discharge was assigned a zero percent exceedance. The same flow duration curve was used for all three minimum flow channel alternatives. This simplification is deemed appropriate for this level of study.

Sediment Transport Capacity

Average annual sediment transport capacity was calculated using the SAM hydraulic design package for each channel modification plan for each of the five reaches. Calculated sediment transport capacity was determined using both the Toffaleti and Yang functions. The results are presented in Table 3.

More dredging is required to maintain the nine-ft-deep navigation channel in the lower minimum discharge channels. Lower minimum discharges require deeper dredged channels across crossings. Therefore, at high and normal discharges, when water surface elevation differences in the three channel alternatives are negligible, the channel cross-sectional area is larger and the channel velocities less. Therefore, it is expected that sediment transport capacity would be the smallest with the 9,300 cfs minimum flow channel and greatest with the 13,000 cfs minimum flow channel. The sediment budget analysis supports this anticipated trend in all reaches. The calculated increase in sediment transport capacity above the 9,300 cfs minimum flow alternative varied between 0.3 and 11.5 percent for the 11,000 cfs minimum flow channel and between 0.5 and 21.1 percent for the 13,000 cfs channel. The average calculated increase in sediment transport capacity for the 11,000 cfs channel was 4.5 percent. The average calculated increase in sediment transport capacity for the 13,000 cfs channel was 8.3 percent. The variability in the calculated sediment transport capacity is attributed to the magnitude of dredging requirements in the individual reaches, and to other hydraulic factors that act to offset the effect of increased channel size. These include: a) increased percentage of flow in the channel due to increased dredging depths

Table 3
Comparison of Calculated Annual Sediment Transport Capacity, Apalachicola River between Apalachicola Bay and Jim Woodruff Lock and Dam

	Navigation Channel Geometry				
	9,300 cfs	11,000 cfs		13,000 cfs	
Reach NM	Existing 1,000 cubic yards per year	1,000 cubic yards per year	Percent of Capacity in 9,300-cfs Channel	1,000 cubic yards per year	Percent of Capacity in 9,300-cfs Channel
Toffaleti Funtion					
17.4 - 19.0	691	723	104.6	748	108.4
35.5 - 37.2	388	415	107.2	439	113.2
38.8 - 41.5	543	545	100.4	545	100.5
60.2 - 66.8	577	588	101.8	590	102.2
87.1 - 87.5	629	661	105.0	695	110.5
Yang Function					
17.4 - 19.0	446	471	105.5	495	110.9
35.5 - 37.2	306	342	111.5	371	121.1
38.8 - 41.5	545	546	100.3	548	100.6
60.2 - 66.8	443	455	102.6	457	103.0
87.1 - 87.5	359	379	105.7	403	112.3

and thus, increased sediment transport potential; and b) increased slope due to lower downstream water-surface elevations created by downstream channel deepening, and thus, increased sediment transport potential.

Sediment transport quantities were higher when the Toffaleti function was used, but percentage differences were greater when the Yang function was used. This demonstrates the sensitivity of the calculation to choice of sediment transport function. The calculated sediment transport capacities are significantly different for the different reaches. This demonstrates the variability of sediment transport capacity through the 100-mile study reach. Aggradation or degradation in specific reaches of the river will depend not only on localized hydraulic and sediment characteristics, but also on upstream and downstream conditions.

4 Recommendations and Conclusions

Dredging activities at one location in a river system affect hydraulic conditions and sediment transport downstream from the dredging location, and, under some conditions, even upstream. The sediment budget approach neglects these system effects. A more detailed study that considers sediment continuity effects is recommended for the next level of planning study. This can be accomplished using the HEC-6 numerical sedimentation model. Recent development of this model by Mr. William Thomas allows for treatment of looped systems such as the Apalachicola River. For the next level of study, generalized sedimentation models of the Alabama River between the Tombigbee River and Claiborne Lock and Dam and of the Apalachicola River between Apalachicola Bay and Jim Woodruff Lock and Dam are recommended to predict the effects of dredging at specific sites and the effects of any channel improvement structures on dredging. These models should include a refinement that includes the longitudinal variation in bed material gradation observed from the measured data. Future studies of the Alabama River should incorporate suspended sediment data collected by the USGS after 1981. These data should be used to determine if there have been any significant sediment load trends over the period of record. In addition it is recommended that suspended sediment measurements be collected on the Apalachicola River at higher flows in order to confirm the sediment transport equations used in the study. The collected suspended sediment samples should be analyzed to determine the particle size distribution of the measured load.

In this study the flow duration curves were assumed to be the same for all minimum flow channels. In future, more rigorous studies, the hydrology should account for different annual hydrographs for each minimum flow channel alternative. Flow distribution into the bypasses and overbanks is critical to sediment transport processes in the Apalachicola River. In this study, flow distribution assumptions were approximate and did not consider any differences in distribution for the alternative minimum flow channels. The next level of planning study should include a more detailed definition of flow distribution. This would best be accomplished with a field data collection effort which established coincident discharges for all major tributaries and distributaries of the Apalachicola main channel. In addition, the geometric models

of both the Alabama and Apalachicola Rivers should be extended to include overbank areas and inclusion of the major cutoff channels.

The sediment budget analysis indicated that differences in the relative sediment transport capacities for the various minimum low-flow channel alternatives on the Alabama and Apalachicola Rivers would be small. On the Alabama River, minimum low-flow channels of 9,500; 6,000; and 5,000 cfs were compared to the existing 7,500 cfs minimum low-flow channel. There was negligible difference in sediment transport capacity between the 9,500 and 7,500 cfs channels. An average increase in sediment transport capacity for the 6,000 cfs channel was calculated to be about 1.2 percent. The calculated increase in sediment transport capacity for the 5,000 cfs channel was about 3.0 percent. On the Apalachicola River, minimum low-flow channels of 11,000 and 13,000 cfs were compared to the existing 9,300 cfs minimum low-flow channel. An average increase in sediment transport capacity of 4.5 percent was calculated for the 11,000 cfs channel. The average calculated increase in sediment transport capacity for the 13,000 cfs channel was 8.3 percent. It may be inferred that relative differences in sediment transport capacity can be used to assess relative differences in rates of deposition.

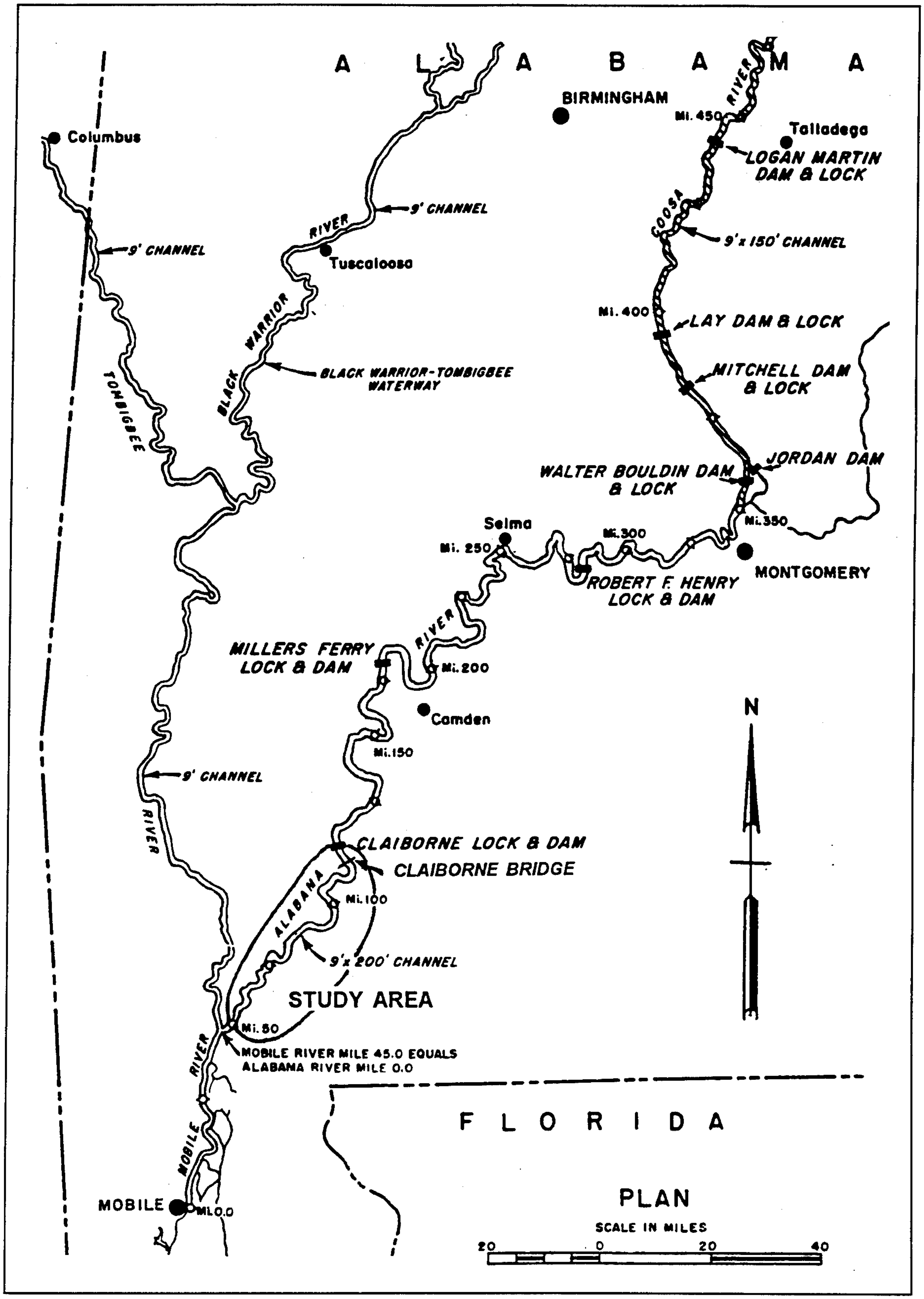

Figure 1. Location and vicinity map, Alabama River

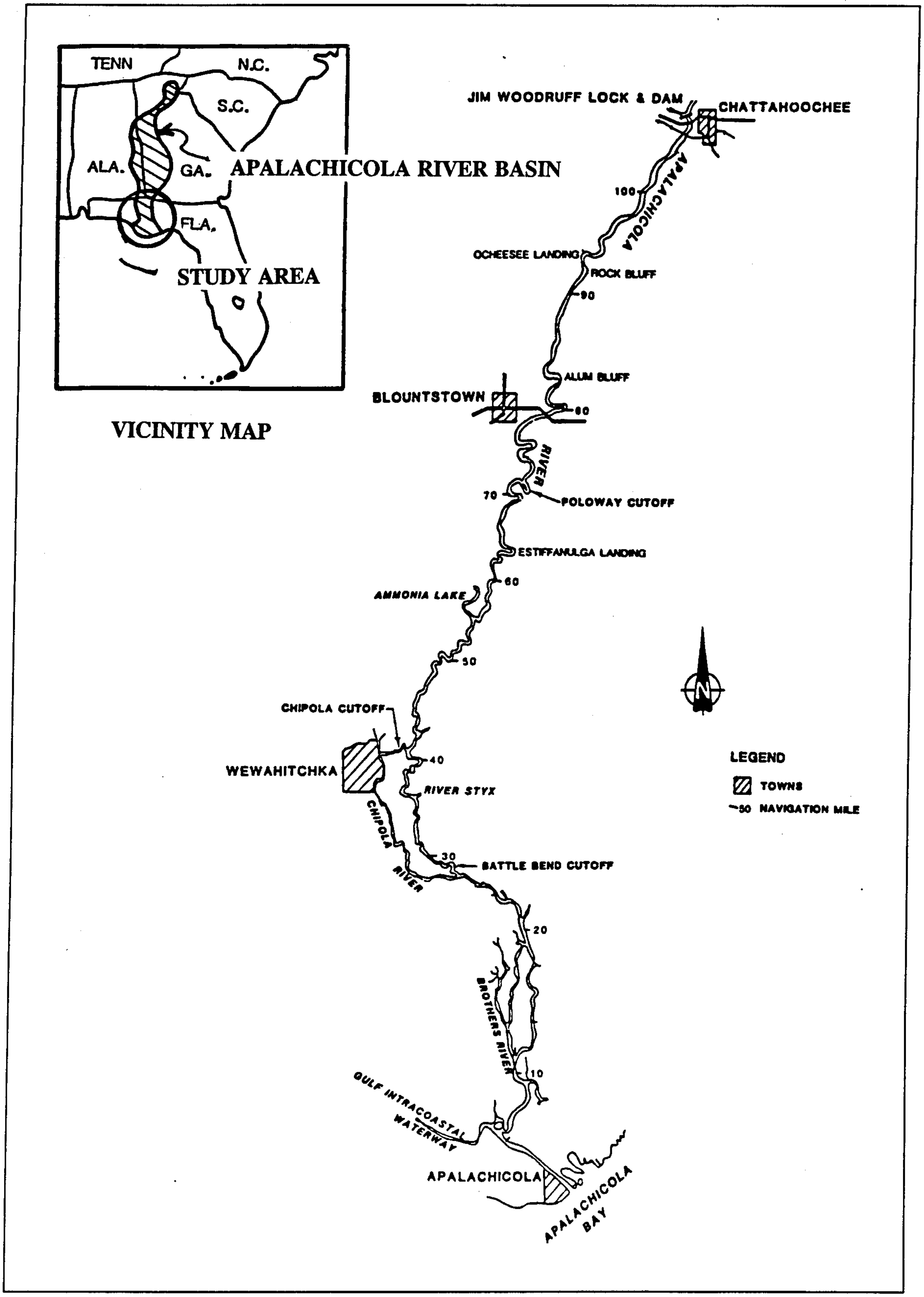

Figure 2. Location and vicinity map, Apalachicola River

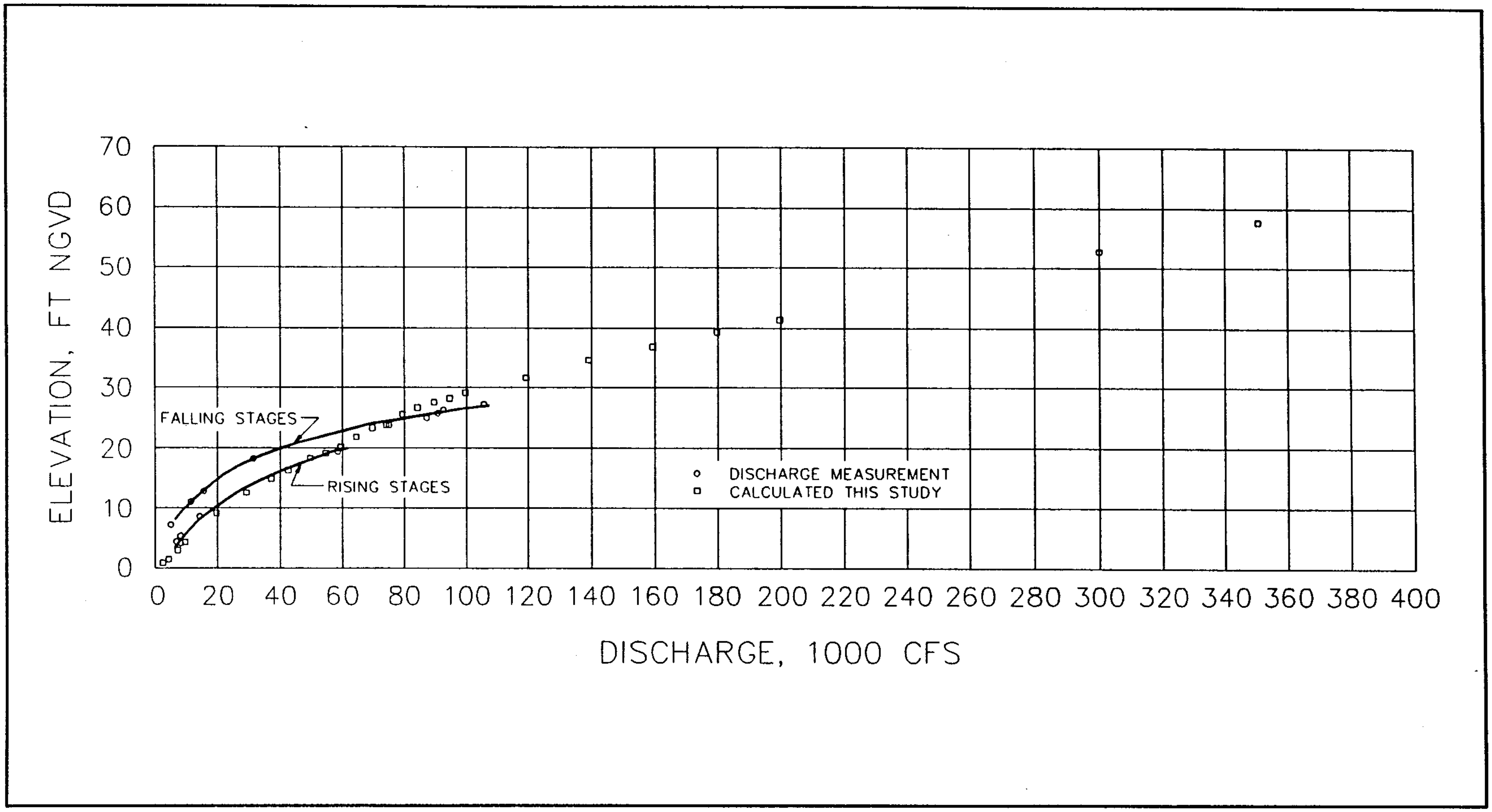

Figure 3. Comparison of measured and calculated stage-discharge curves, Choctaw Bluff, NM 32.9, Alabama River

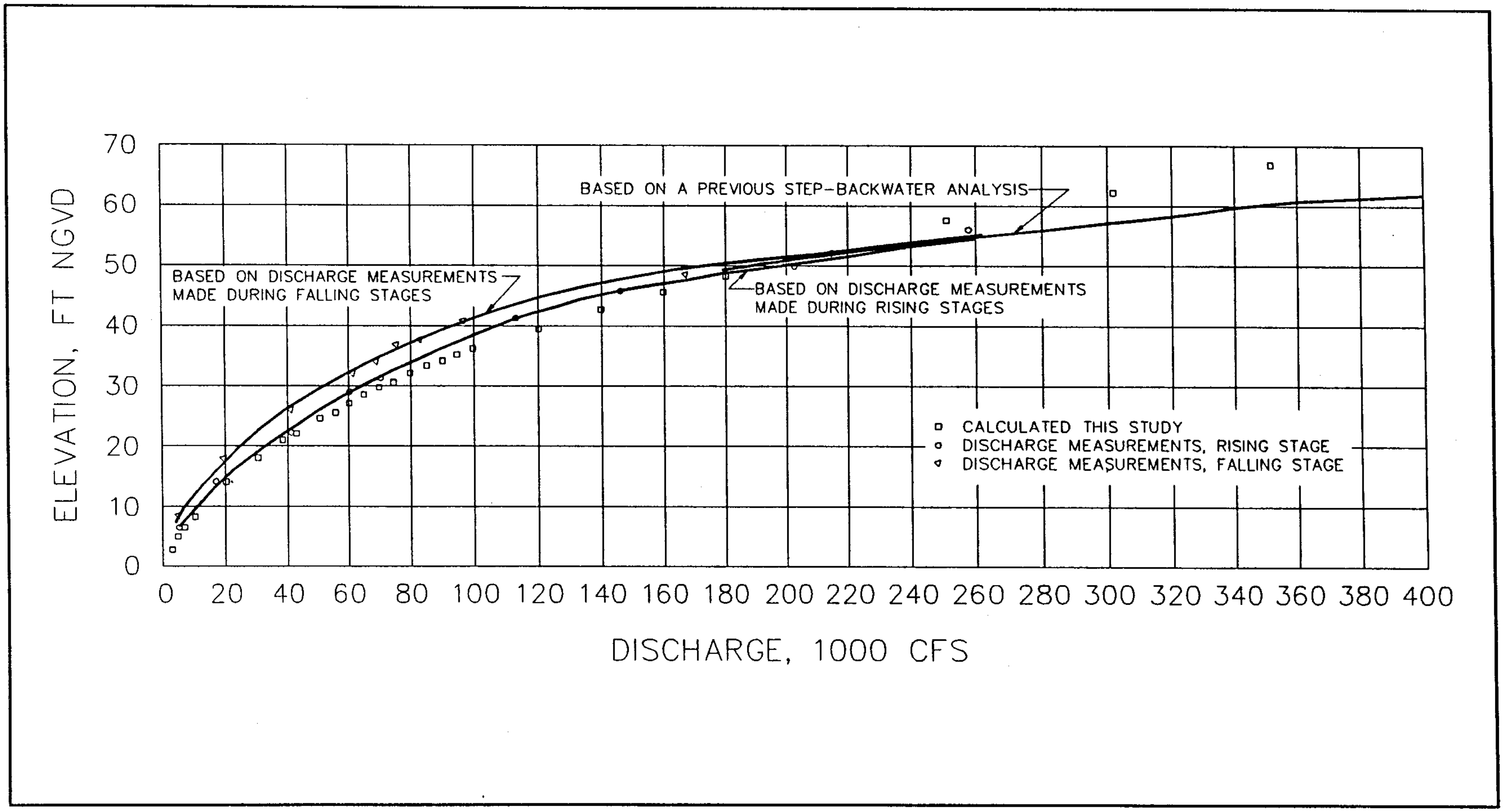

Figure 4. Comparison of measured and calculated stage-discharge curves, Claiborne, AL, NM 66.8, Alabama River

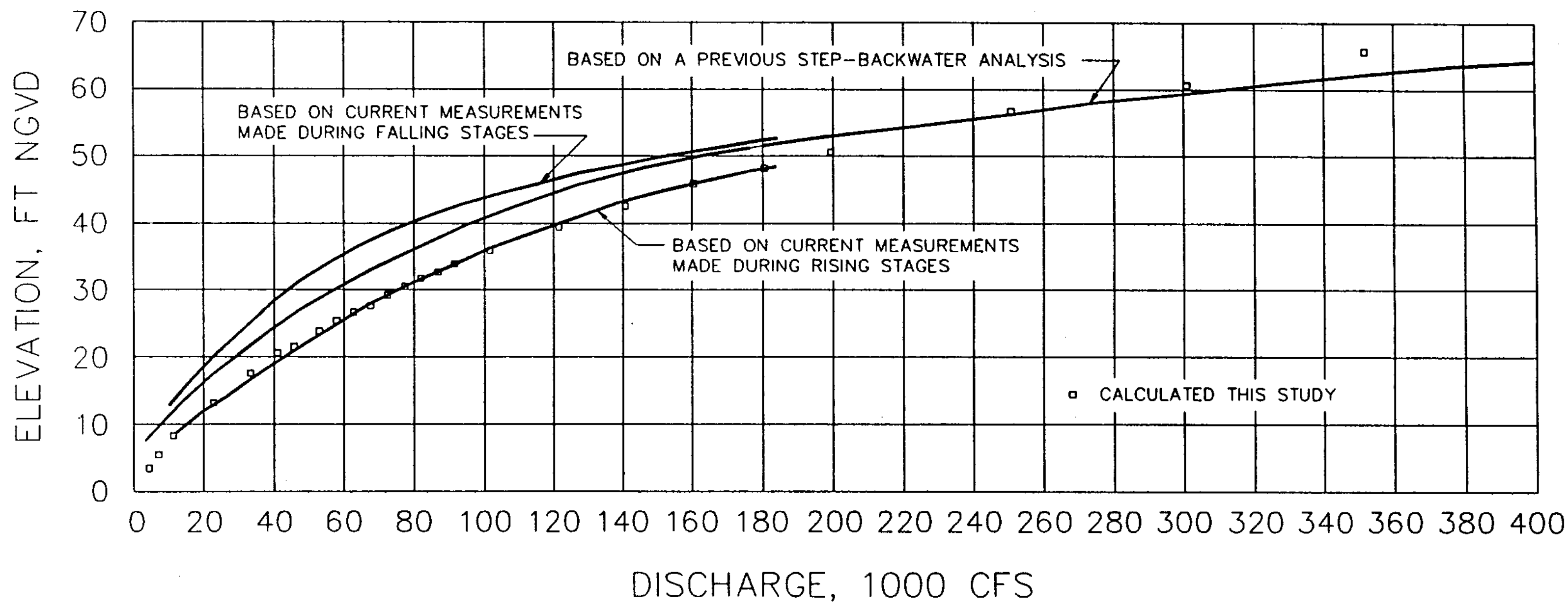

Figure 5. Comparison of measured and calculated stage-discharge curves, Claiborne Lock and Dam, NM 72.4, Alabama River

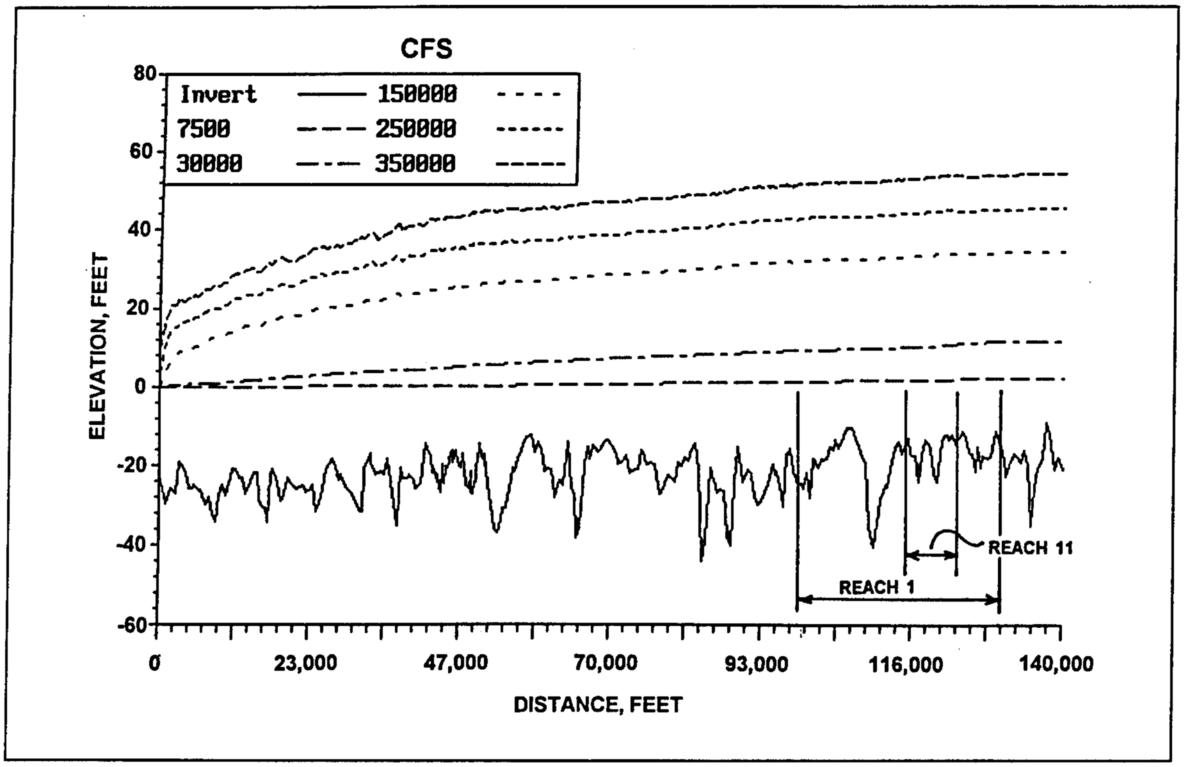

Figure 6. Location of study reaches shown with water surface elevations and thalweg, calculated from the 7,500 cfs data, from 0 to 140,000 ft upstream of NM 0.0, Alabama River

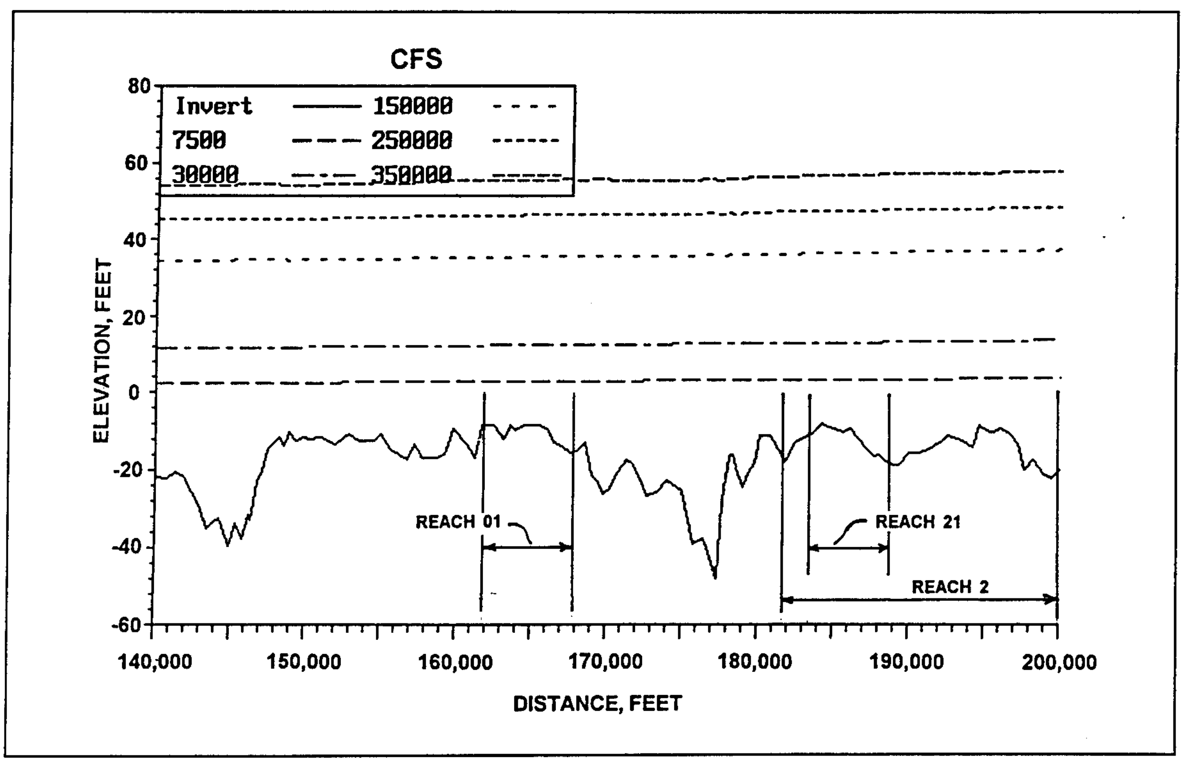

Figure 7. Location of study reaches shown with water surface elevations and thalweg, calculated from the 7,500 cfs data, from 140,000 to 200,000 ft upstream of NM 0.0, Alabama River

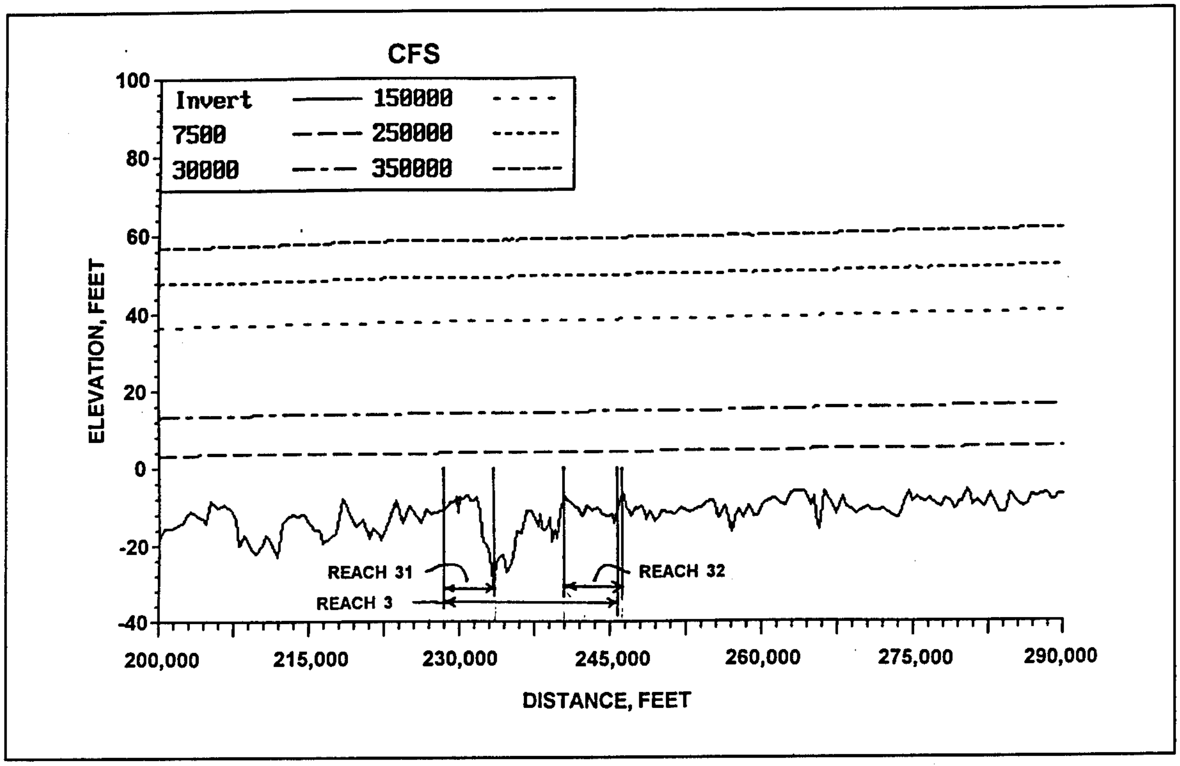

Figure 8. Location of study reaches shown with water surface elevations and thalweg, calculated from the 7,500 cfs data, from 200,000 to 290,000 ft upstream of NM 0.0, Alabama River

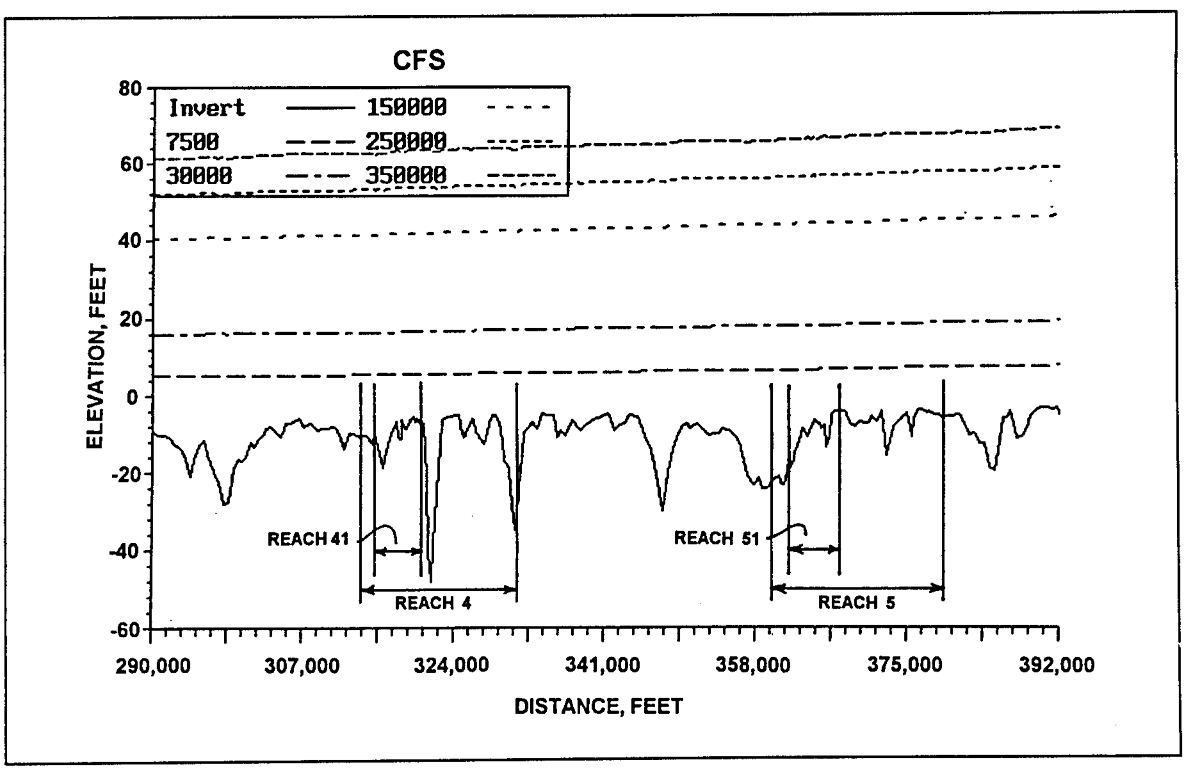

Figure 9. Location of study reaches shown with water surface elevations and thalweg, calculated from the 7,500 cfs data, from 290,000 to 392,000 ft upstream of NM 0.0, Alabama River

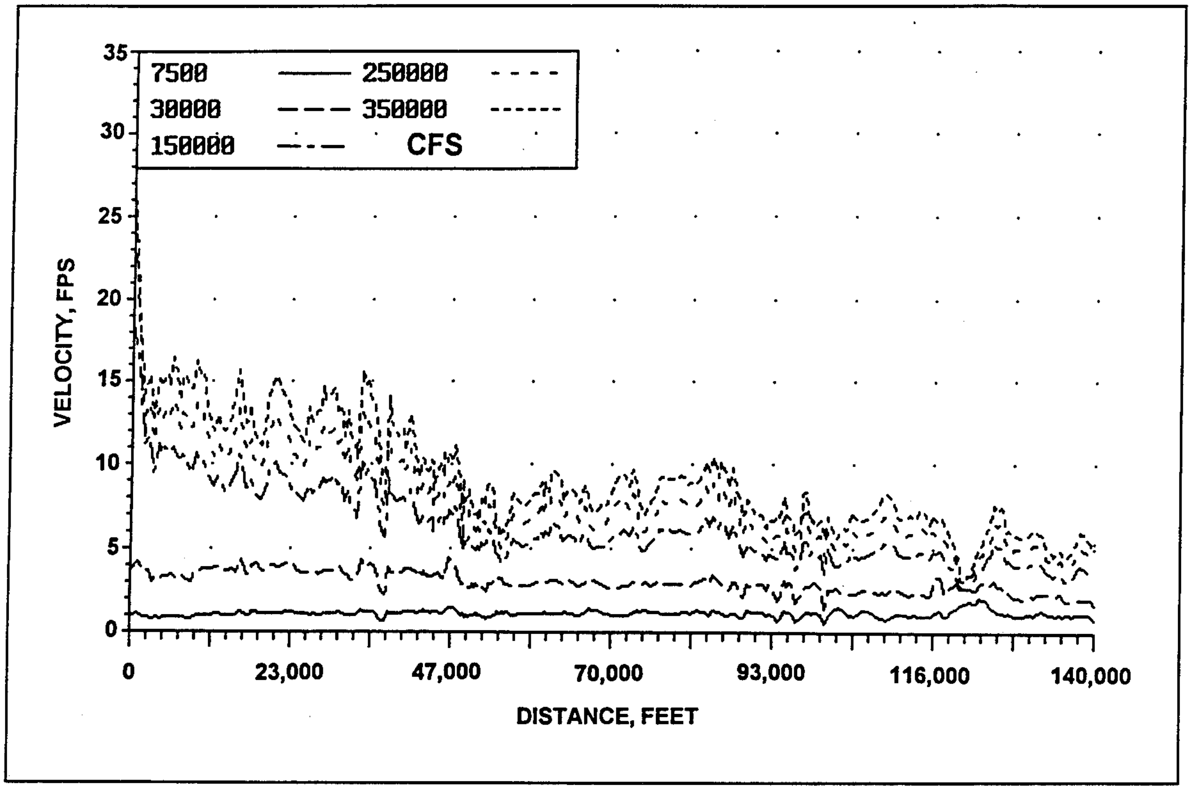

Figure 10. Calculated channel velocities calculated from the 7,500 cfs data, from 0 to 140,000 ft upstream of NM 0.0, Alabama River

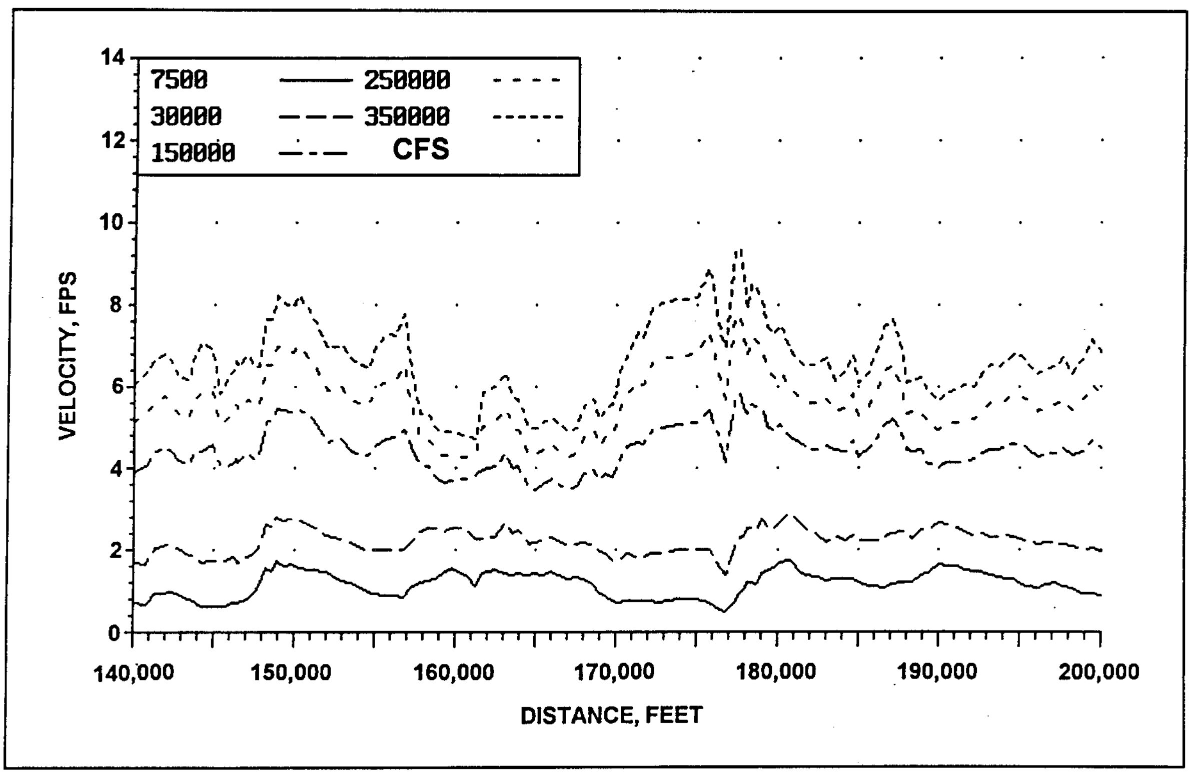

Figure 11. Calculated channel velocities calculated from the 7,500 cfs data, from 140,000 to 200,000 ft upstream of NM 0.0, Alabama River

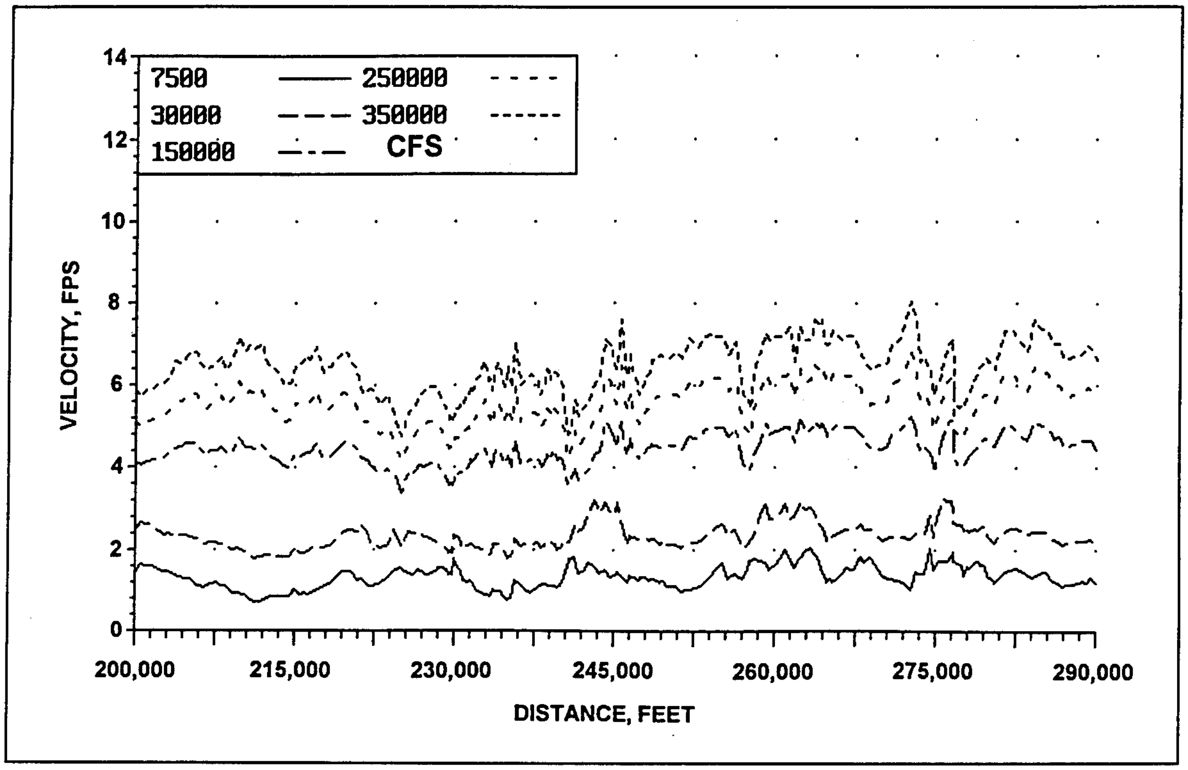

Figure 12. Calculated channel velocities calculated from the 7,500 cfs data, from 200,000 to 290,000 ft upstream of NM 0.0, Alabama River

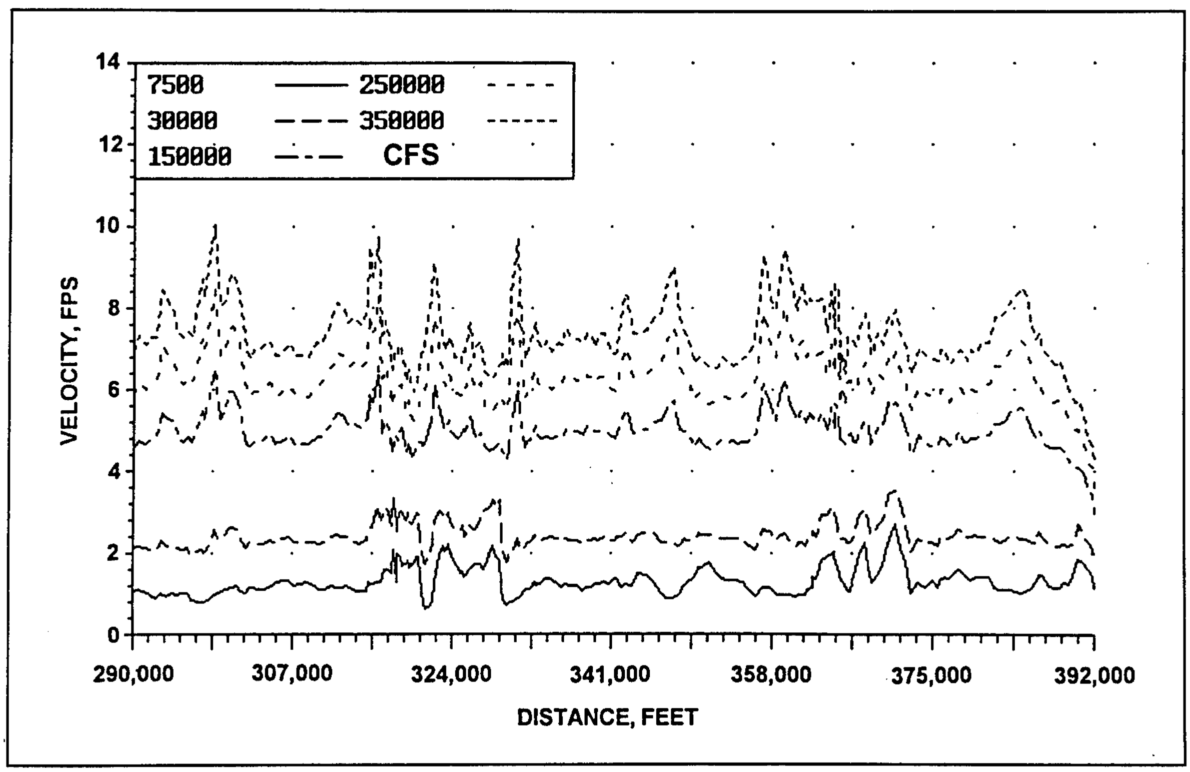

Figure 13. Calculated channel velocities calculated from the 7,500 cfs data, from 290,000 392,000 ft upstream of NM 0.0, Alabama River

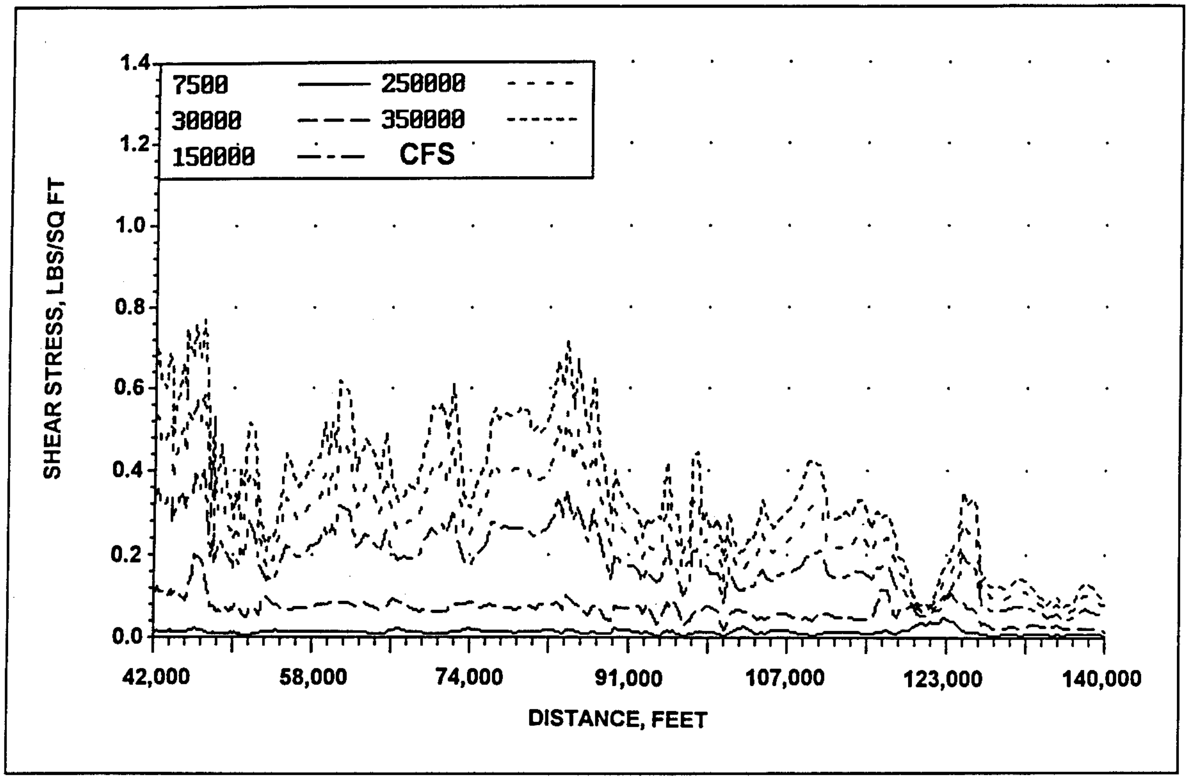

Figure 14. Shear stress calculated from the 7,500 cfs data, from 42,000 to 140,000 ft upstream of NM 0.0, Alabama River

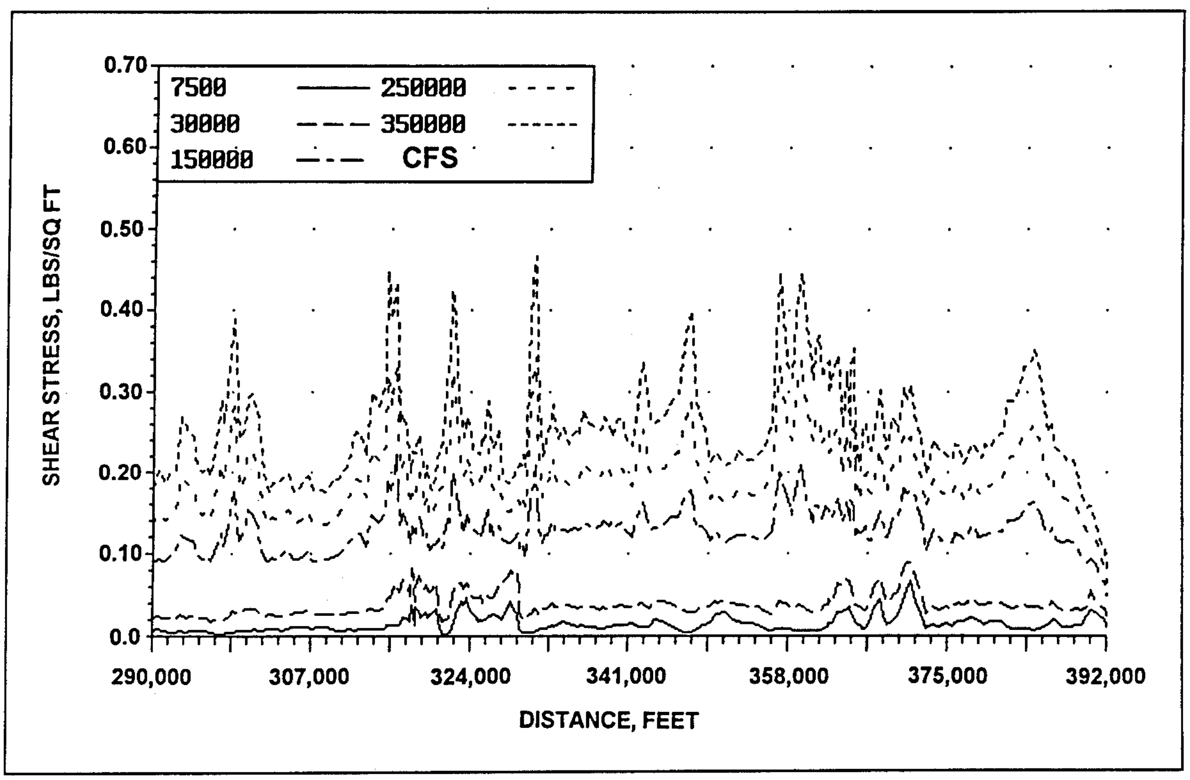

Figure 15. Shear stress calculated from the 7,500 cfs data, from 140,000 to 200,000 ft upstream of NM 0.0, Alabama River

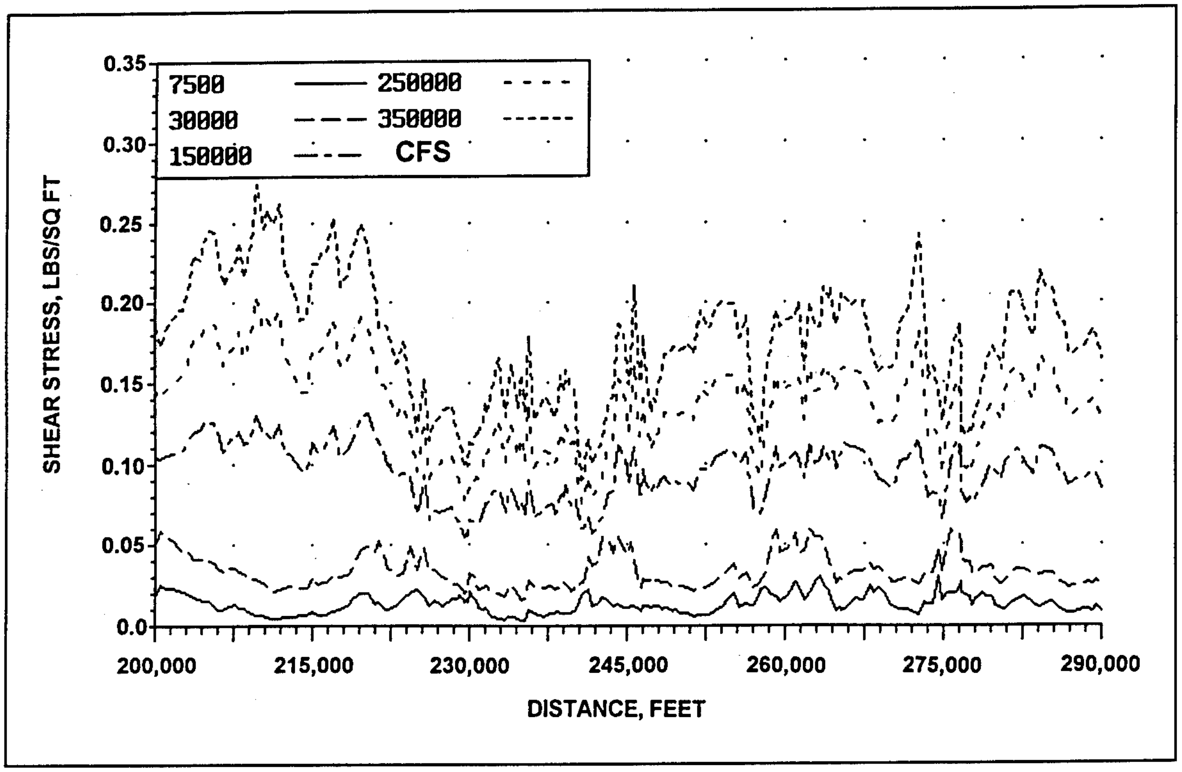

Figure 16. Shear stress calculated from the 7,500 cfs data, from 200,000 to 290,000 ft upstream of NM 0.0, Alabama River

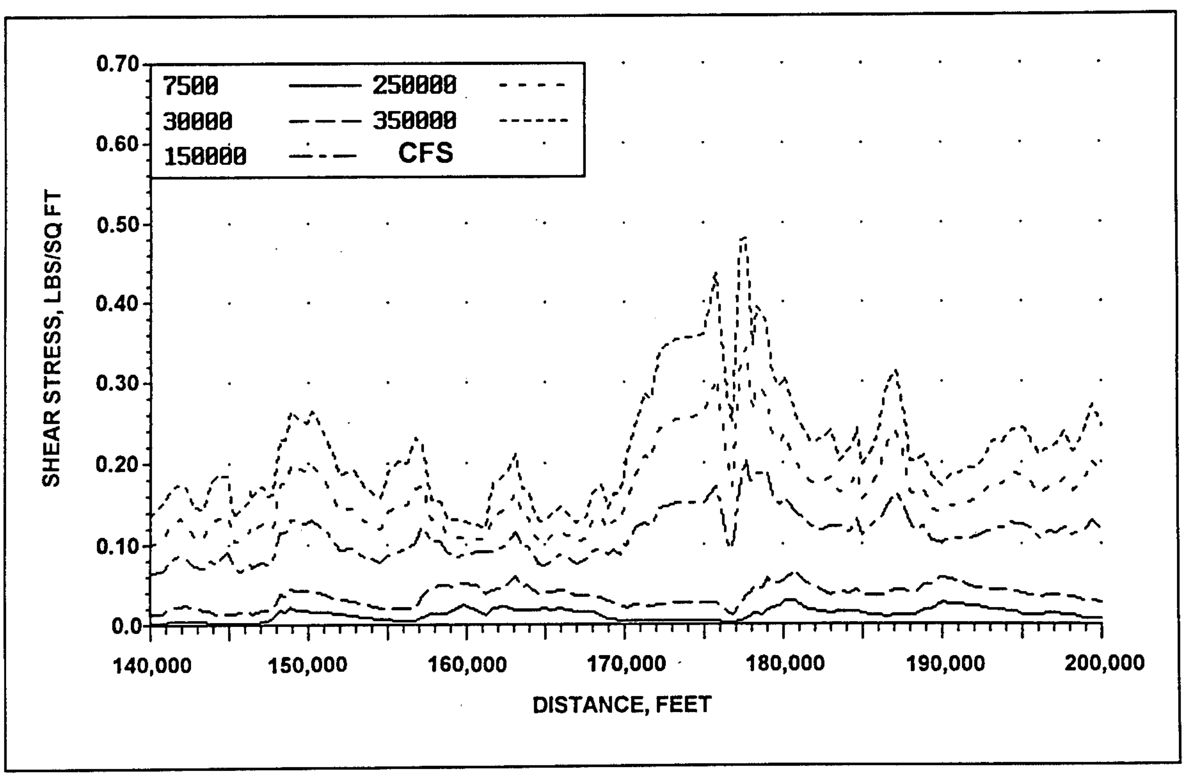

Figure 17. Shear stress calculated from the 7,500 cfs data, from 290,000 to 392,000 ft upstream of NM 0.0, Alabama River

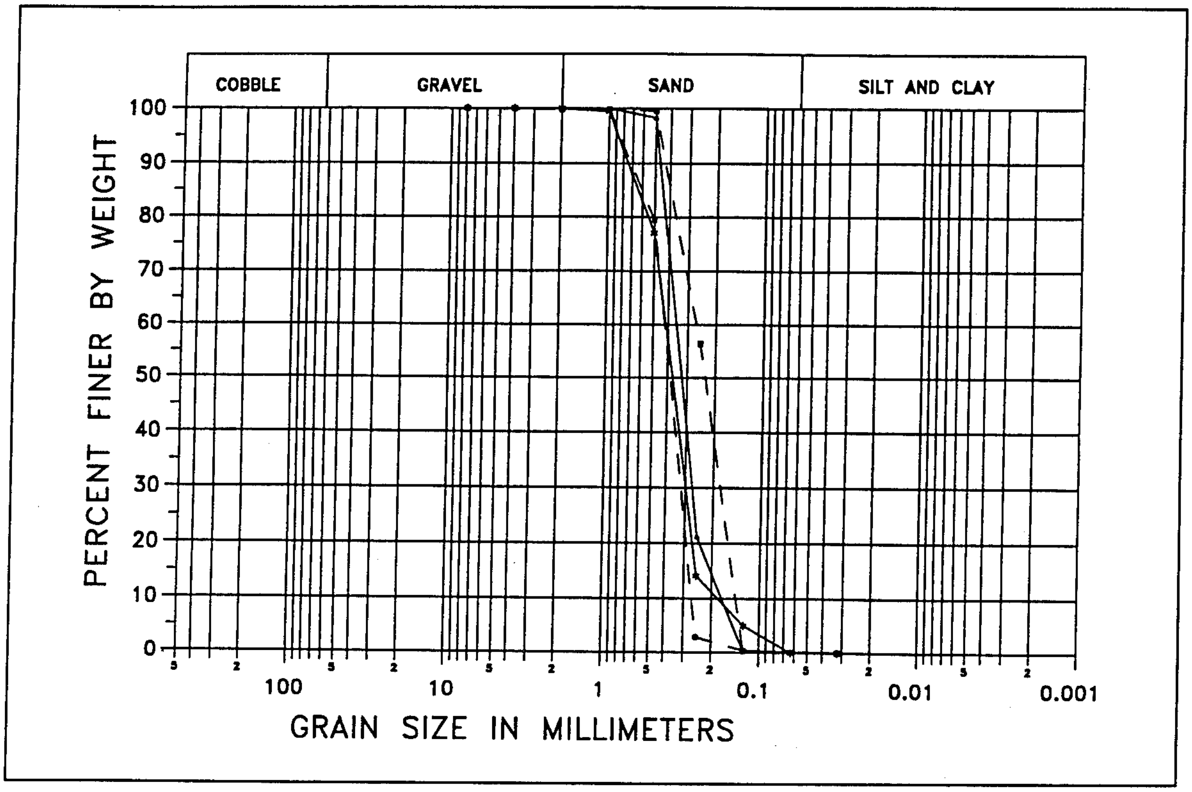

Figure 18. Sediment gradation collected in 1994, from mile 5.2, Alabama River

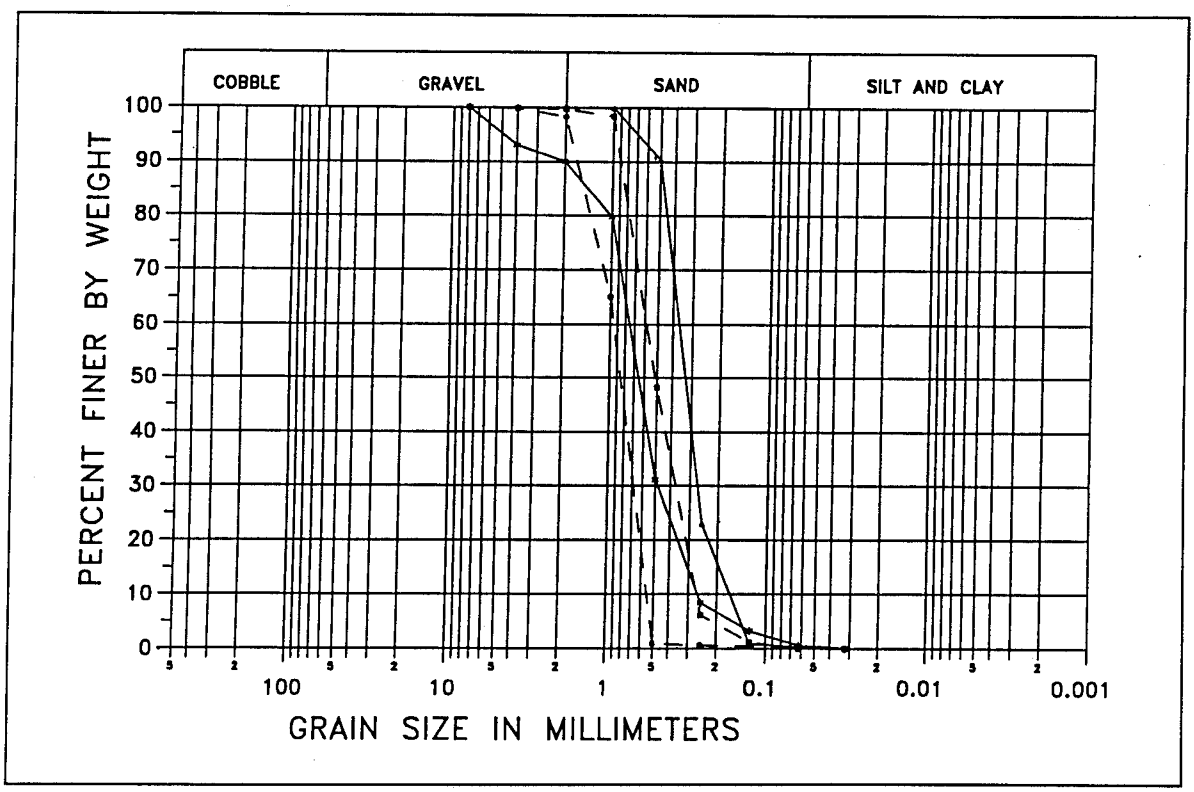

Figure 19. Sediment gradation collected in 1994, from mile 13.5, Alabama River

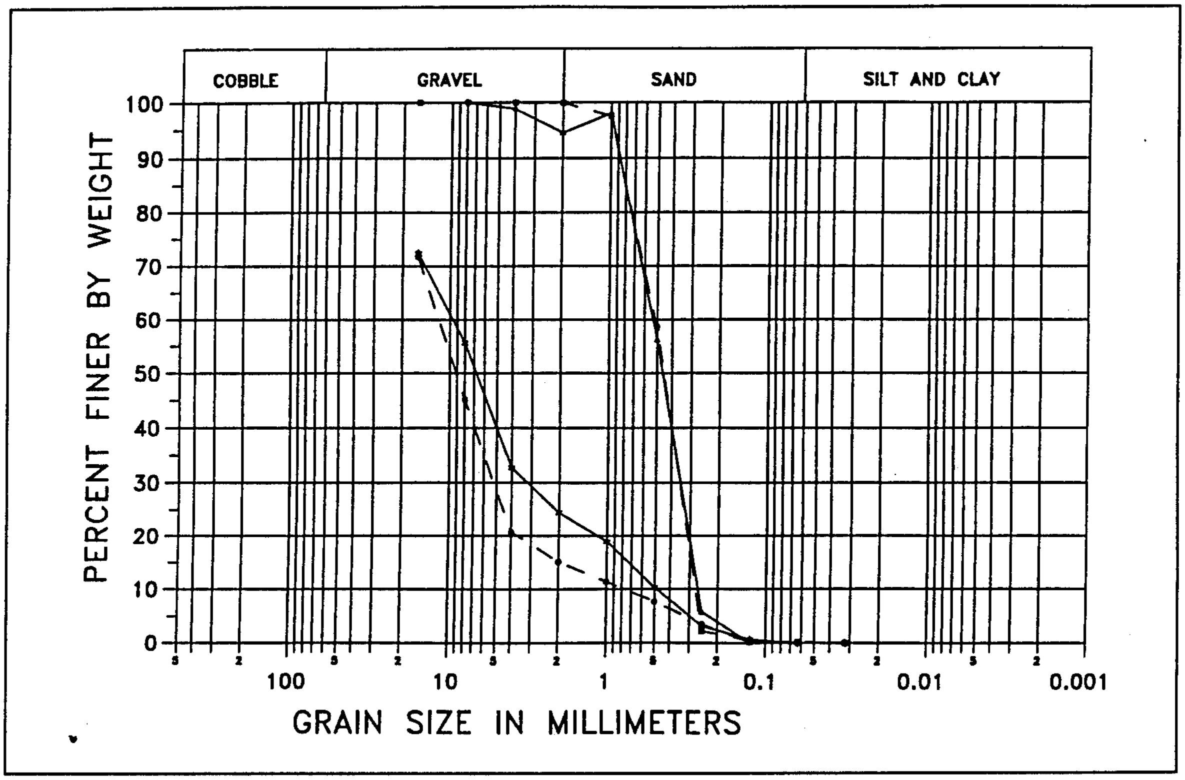

Figure 20. Sediment gradation collected in 1994, from mile 19.0, Alabama River

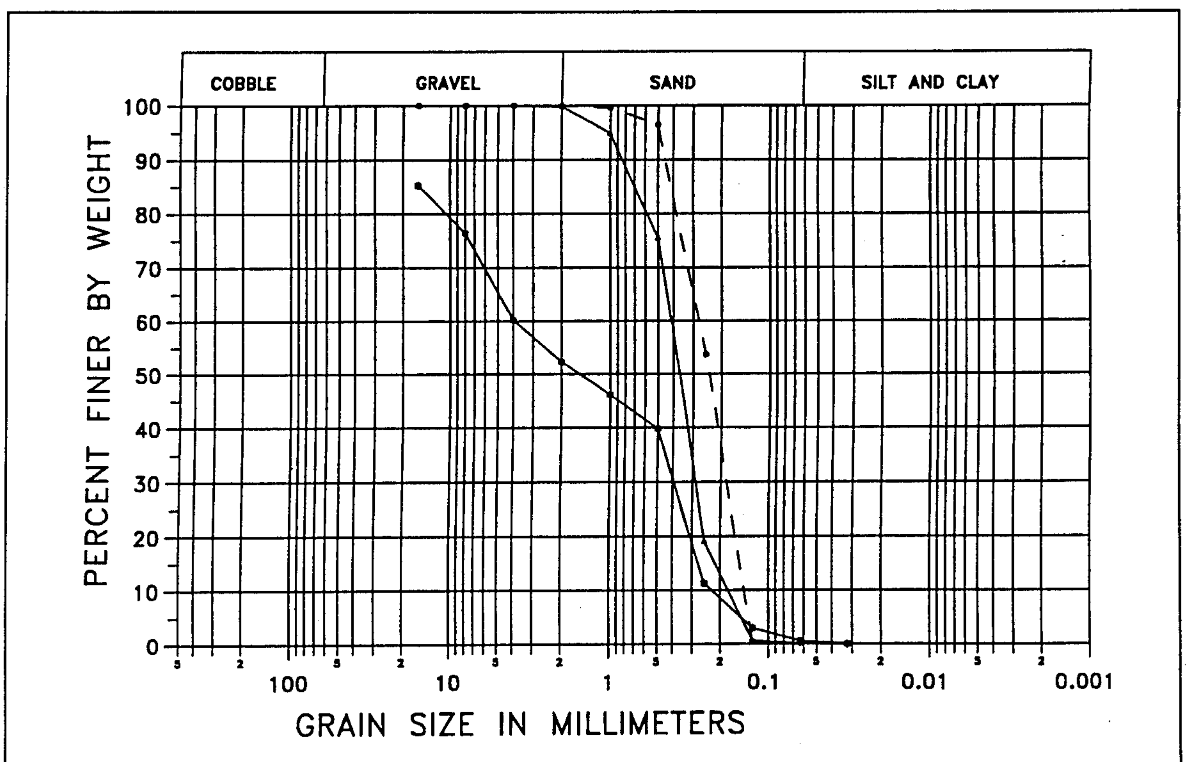

Figure 21. Sediment gradation collected in 1994, from mile 26.2, Alabama River

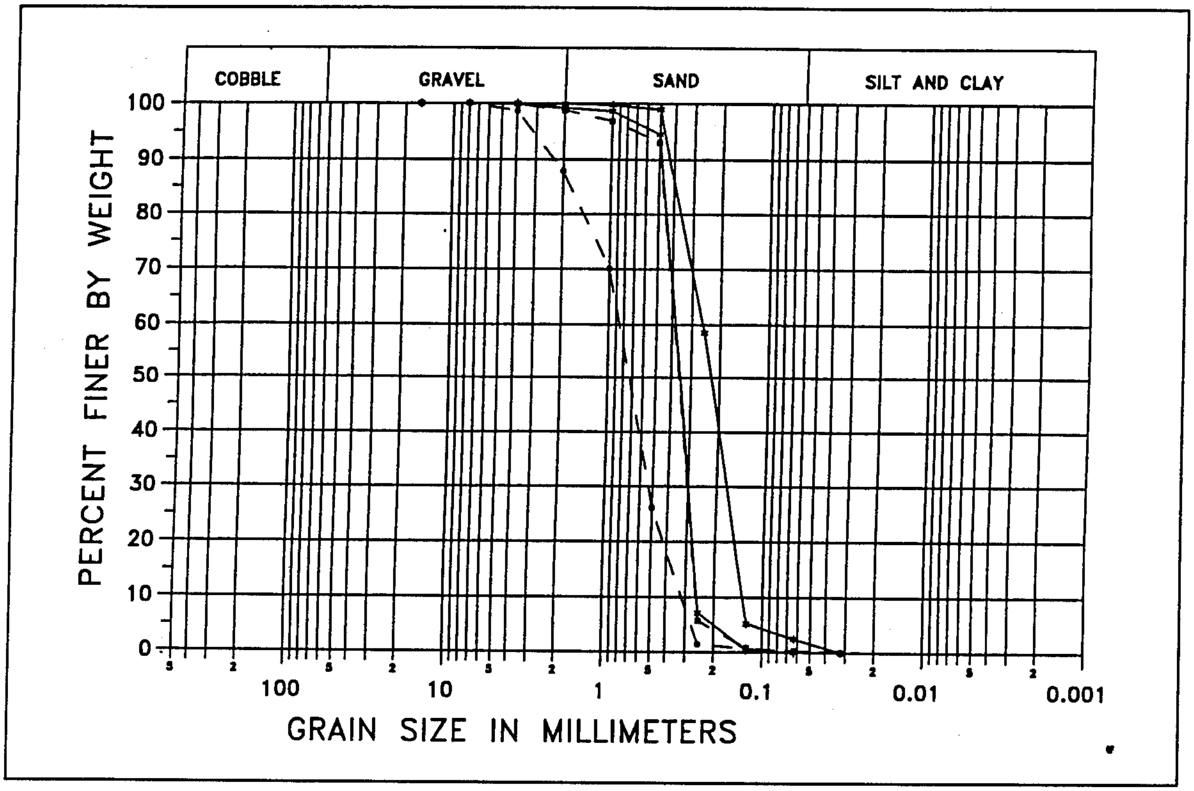

Figure 22. Sediment gradation collected in 1994, from mile 34.5, Alabama River

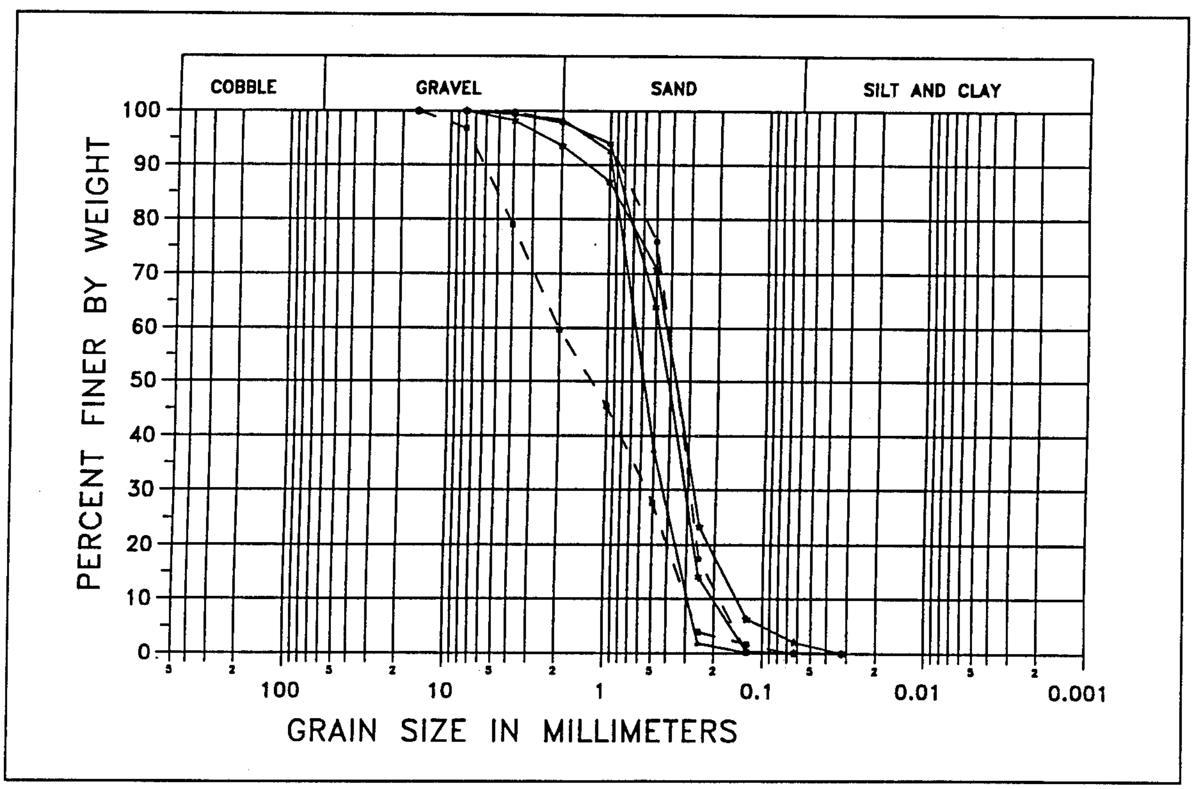

Figure 23. Sediment gradation collected in 1994, from mile 35.2, Alabama River

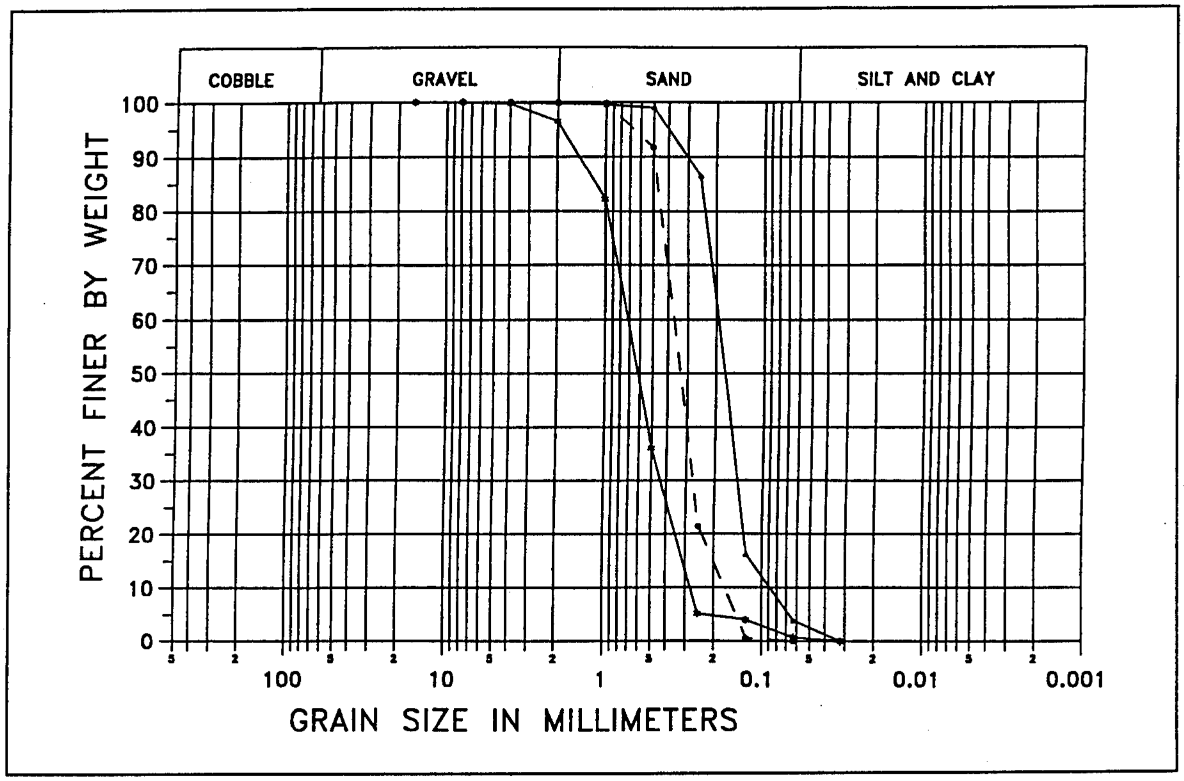

Figure 24. Sediment gradation collected in 1994, from mile 41.2, Alabama River

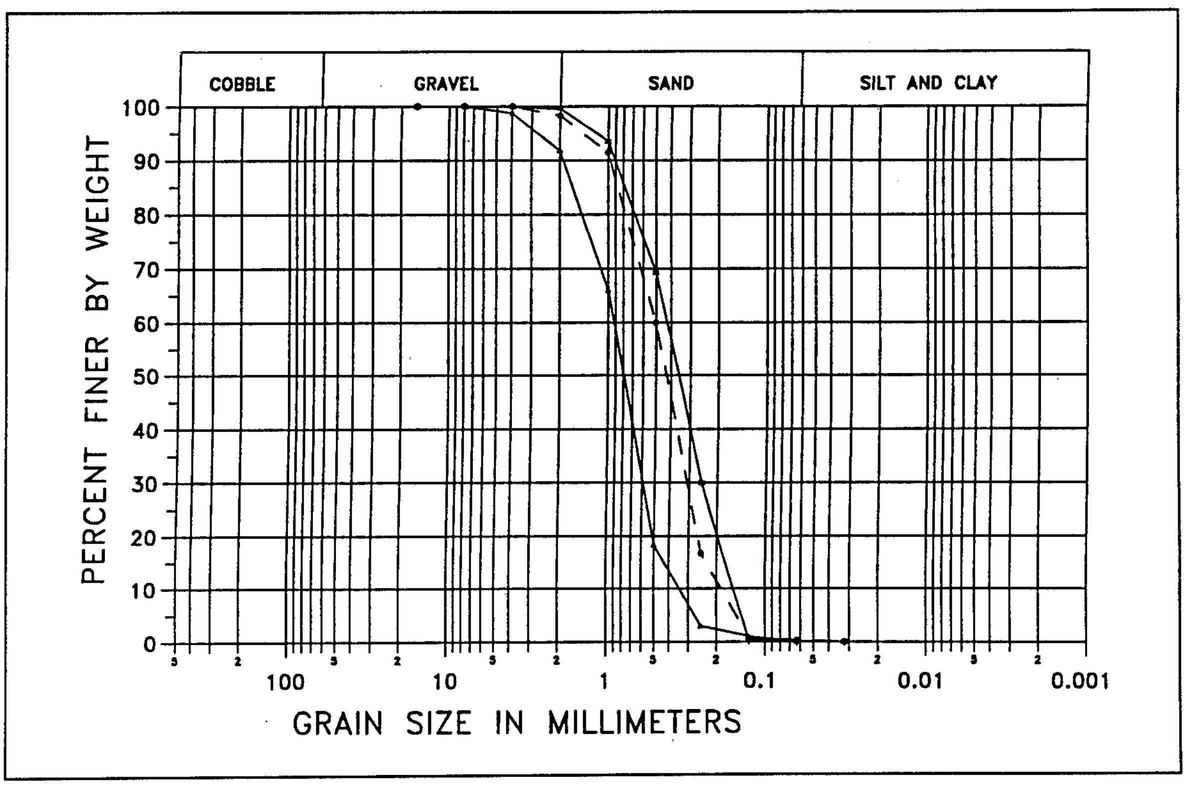

Figure 25. Sediment gradation collected in 1994, from mile 52.0, Alabama River

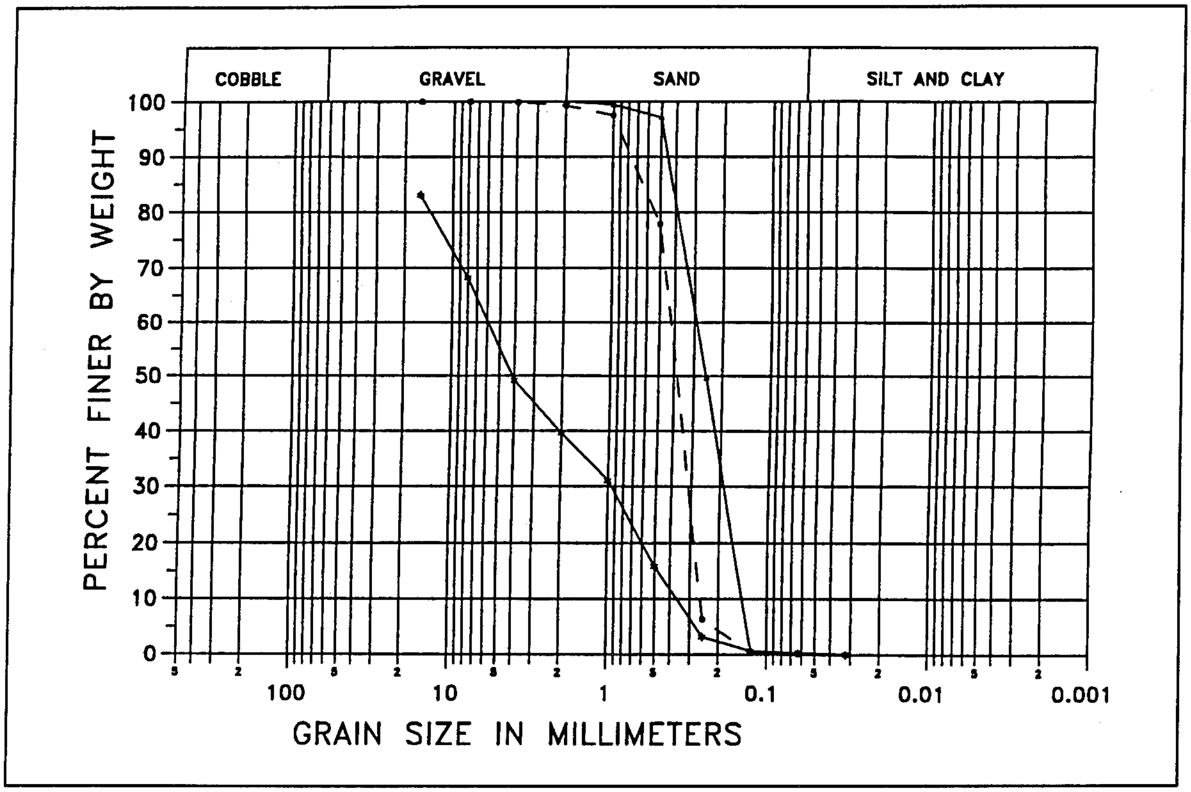

Figure 26. Sediment gradation collected in 1994, from mile 58.2, Alabama River

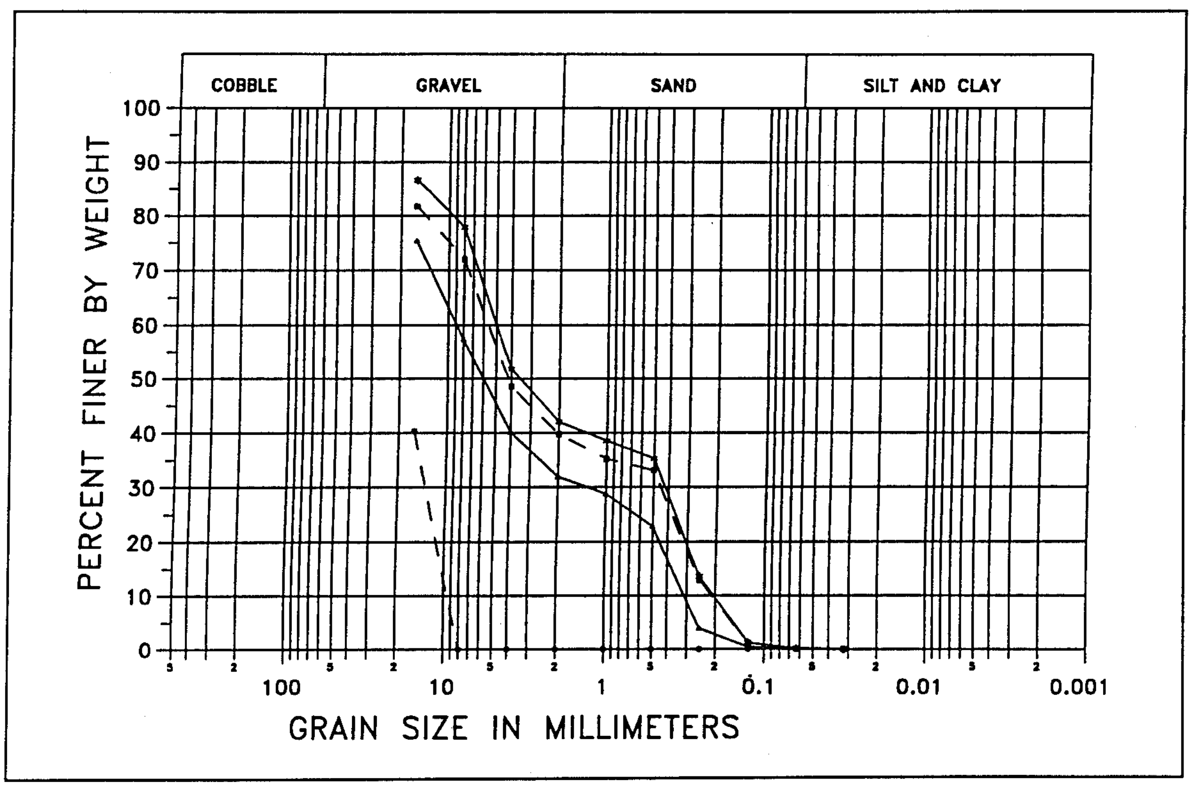

Figure 27. Sediment gradation collected in 1994, from mile 68.0, Alabama River

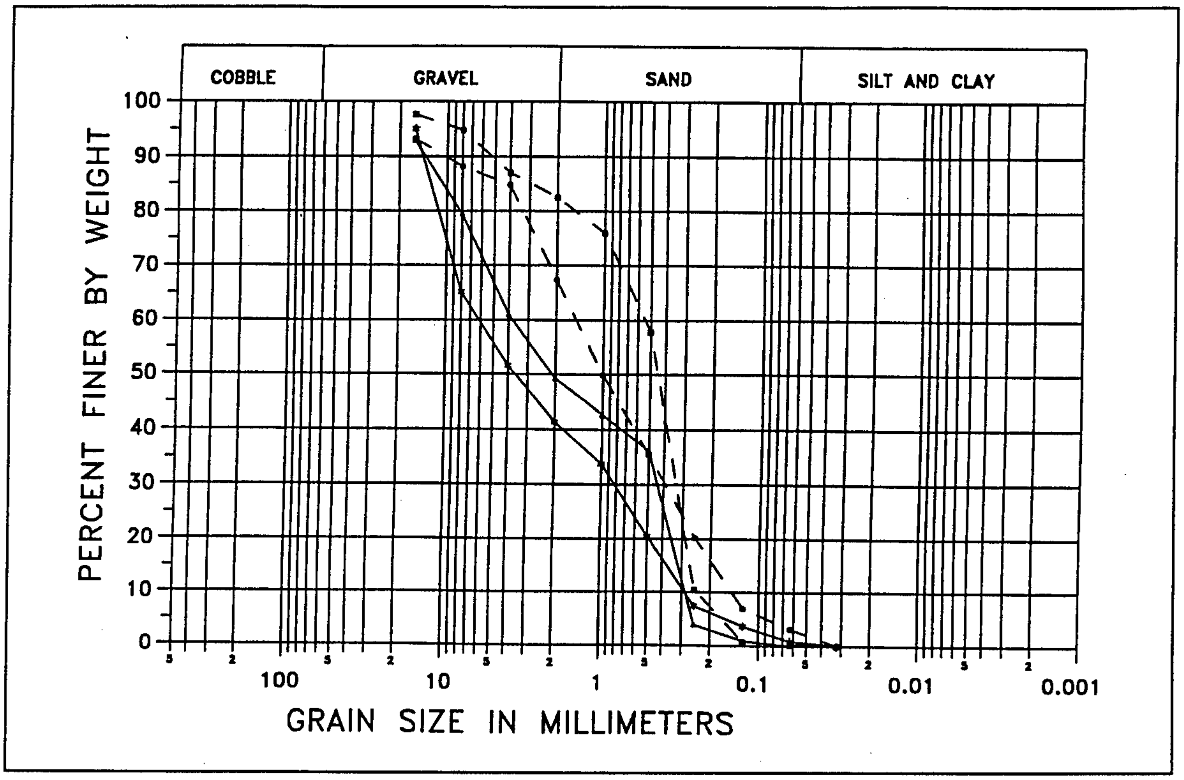

Figure 28. Sediment gradation collected in 1994, from mile 69.8, Alabama River

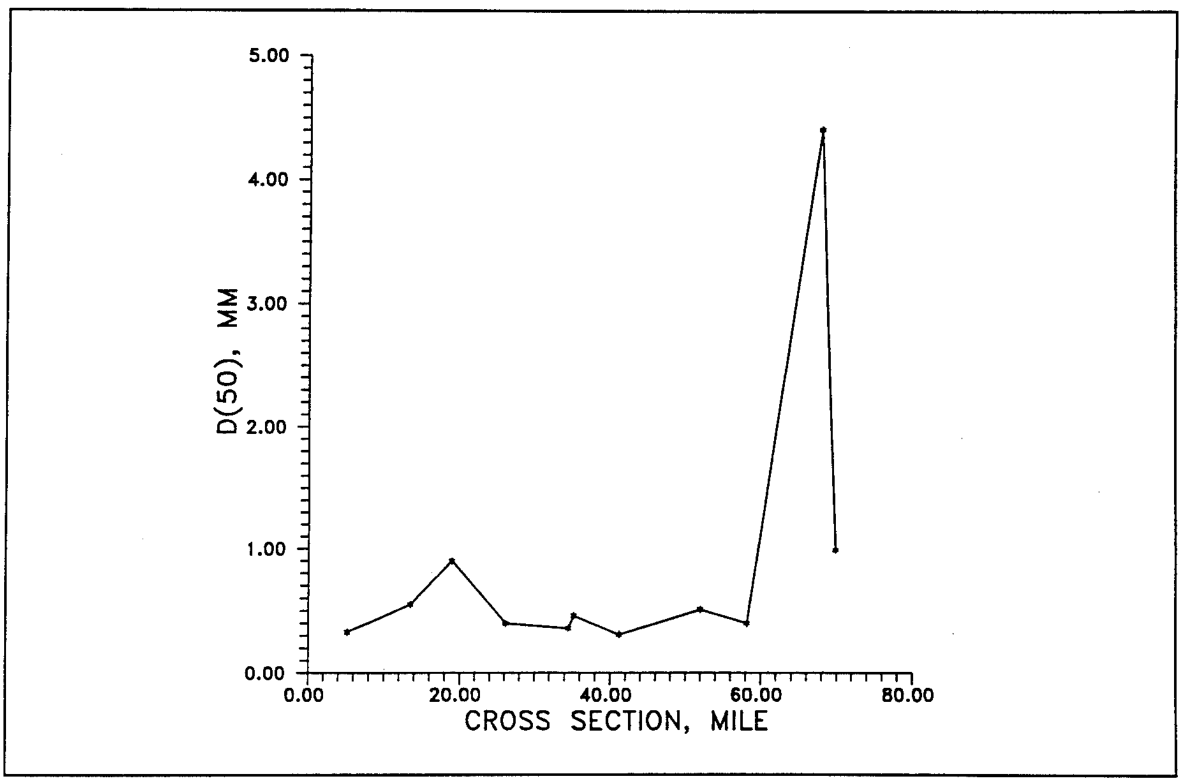

Figure 29. Average longitudinal variation in average median grain size, Alabama River

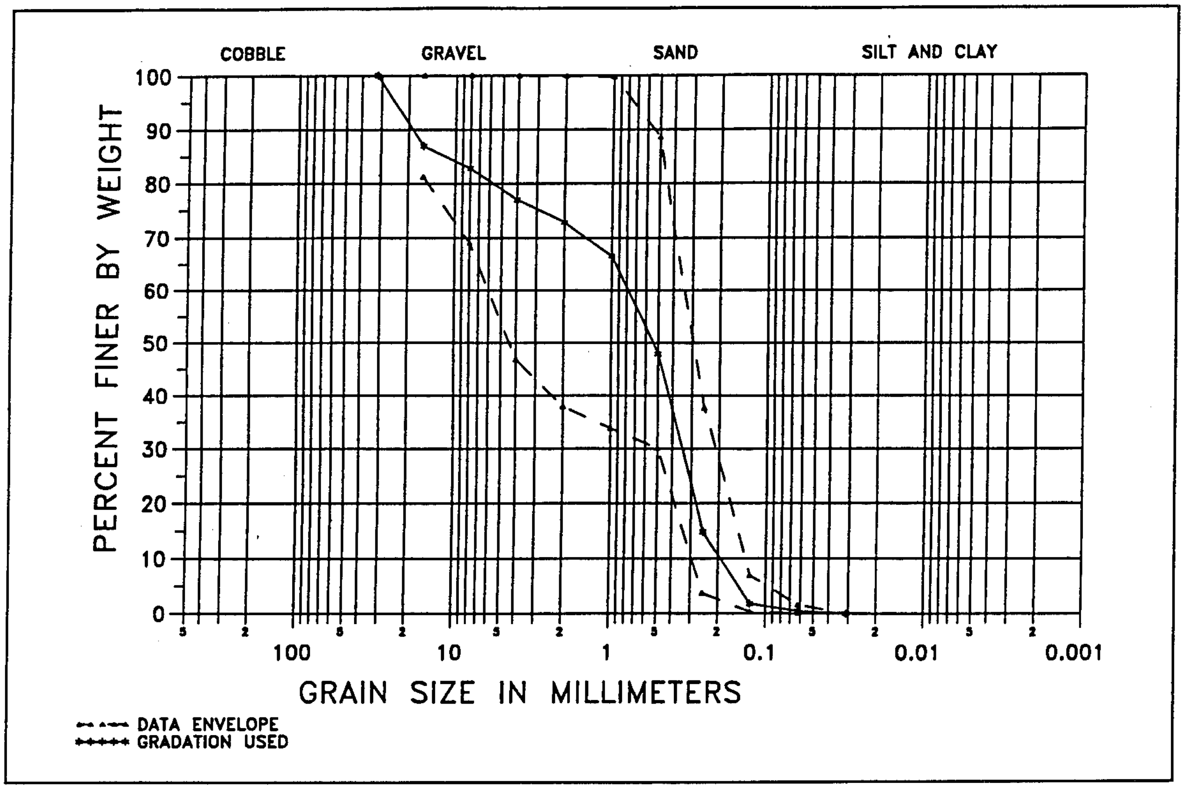

Figure 30. Average gradation and envelope of measured data, Alabama River

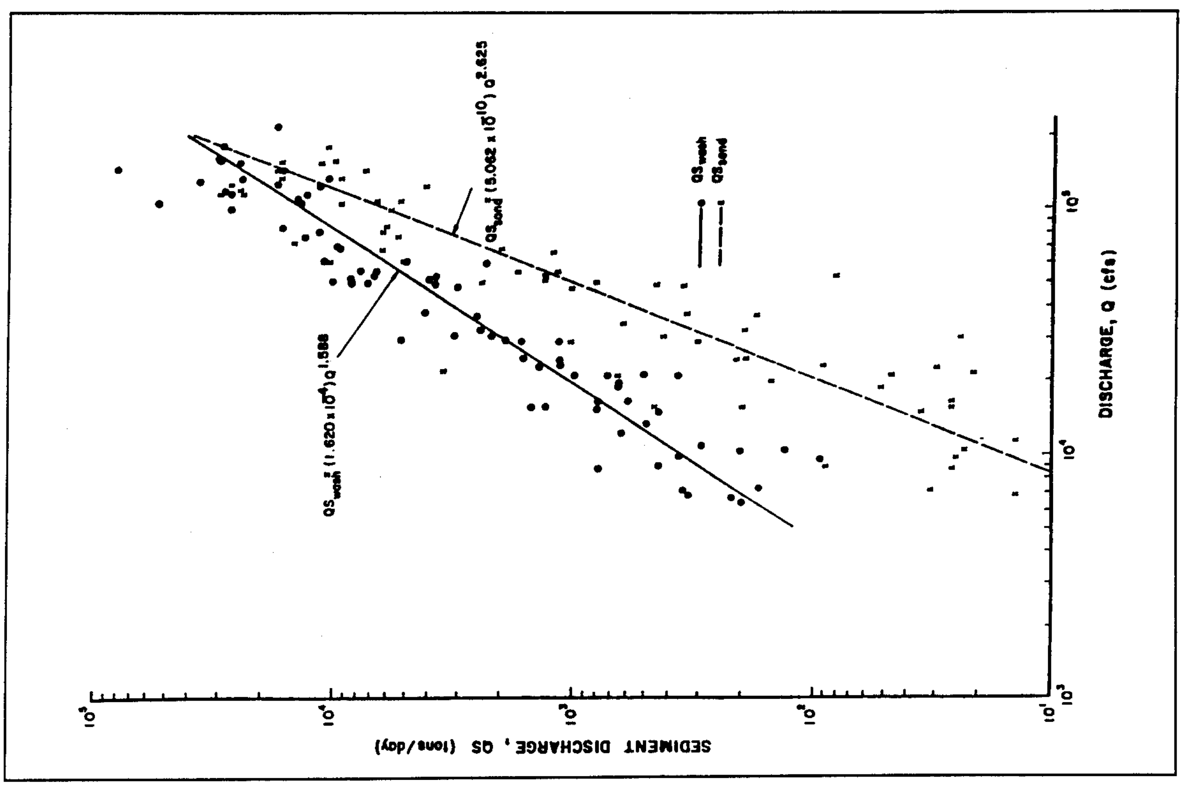

Figure 31. Sediment discharge relationships for the Alabama River at Claiborne

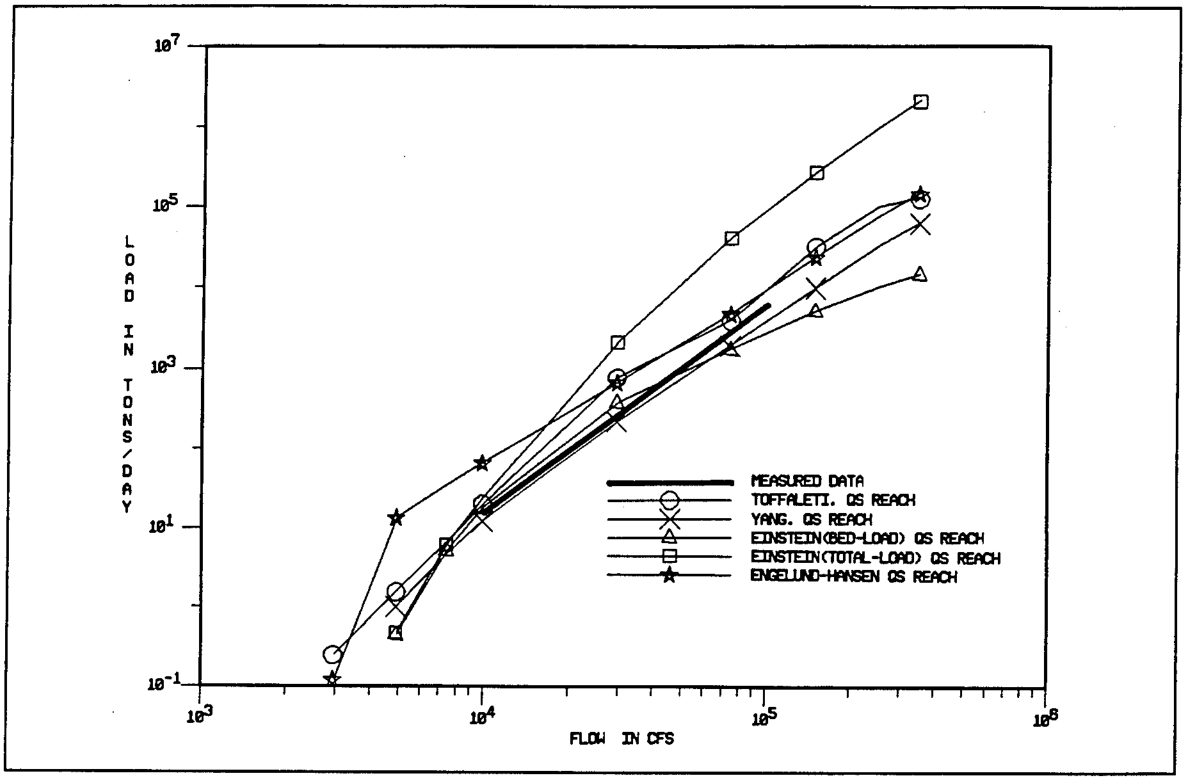

Figure 32. Calculated results from five sediment transport functions, compared to measured data, Alabama River

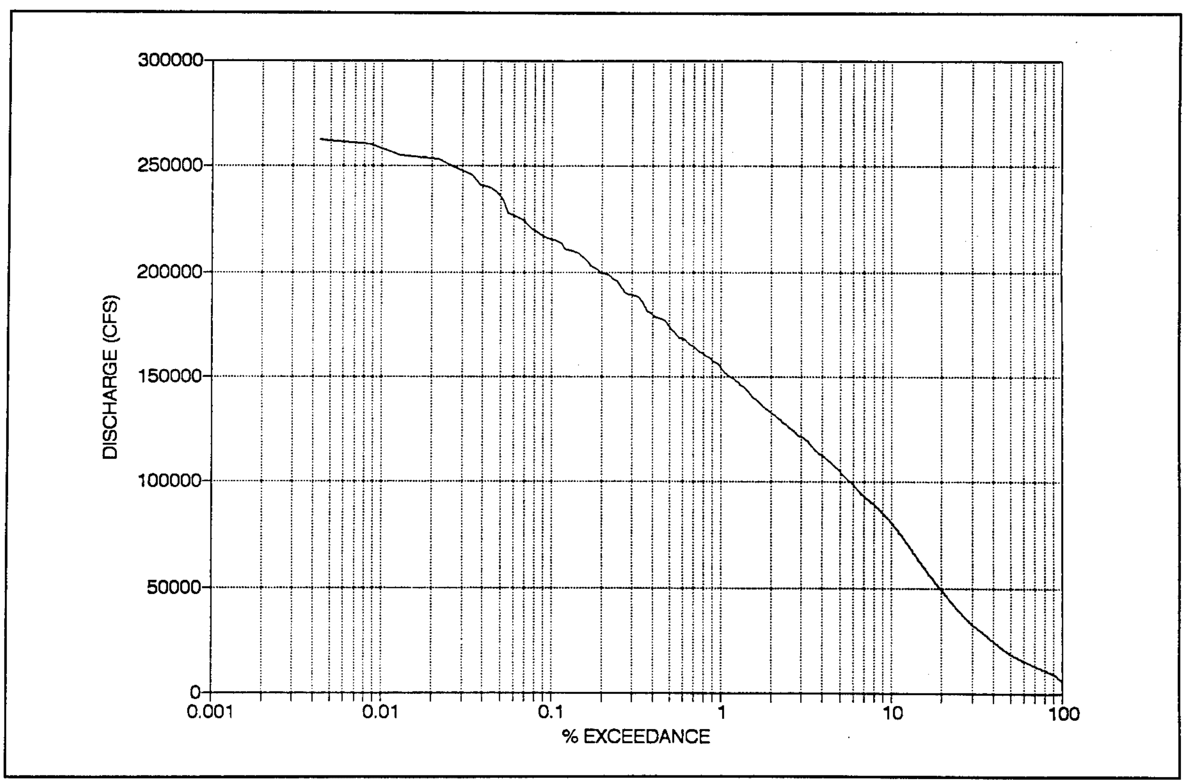

Figure 33. Flow duration curve, data from the Alabama River at Claiborne and the Alabama River at Claiborne Lock and Dam combined, 1930 - 1993

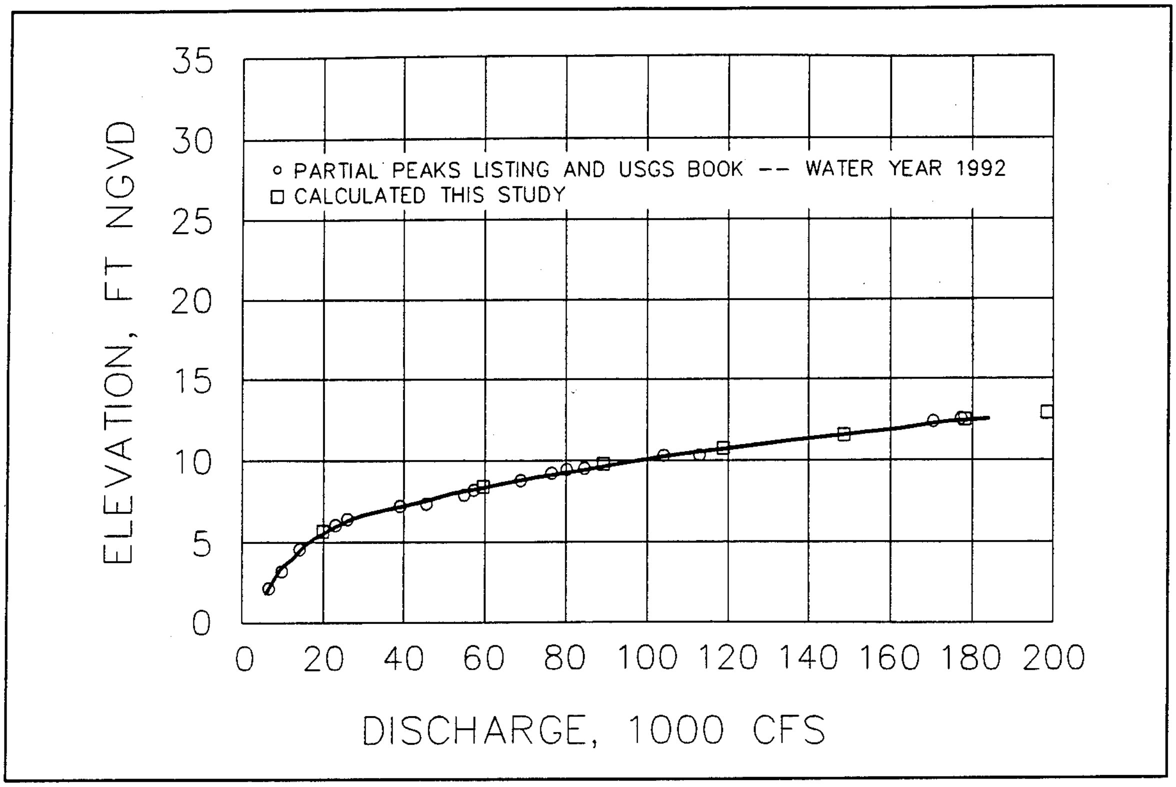

Figure 34. Comparison of measured and calculated stage-discharge rating curves, Apalachicola River near Sumatra

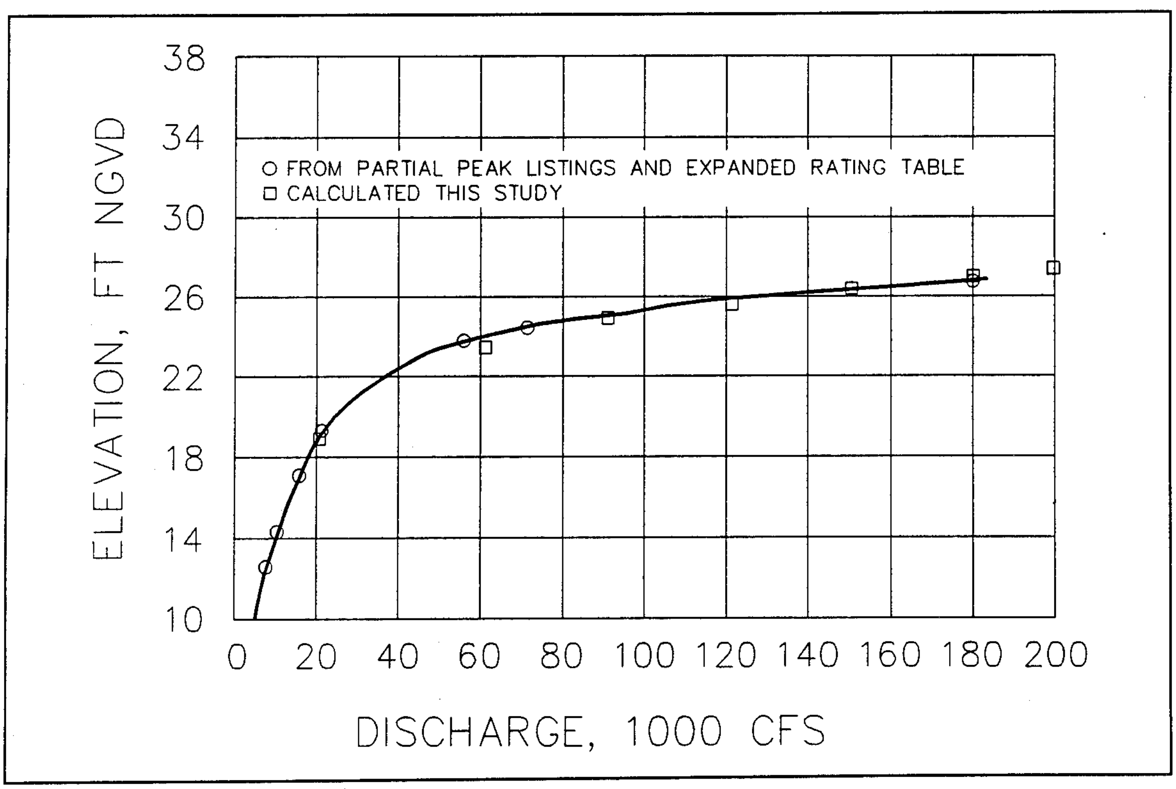

Figure 35. Comparison of measured and calculated stage-discharge rating curves, Apalachicola River near Wewahitchka

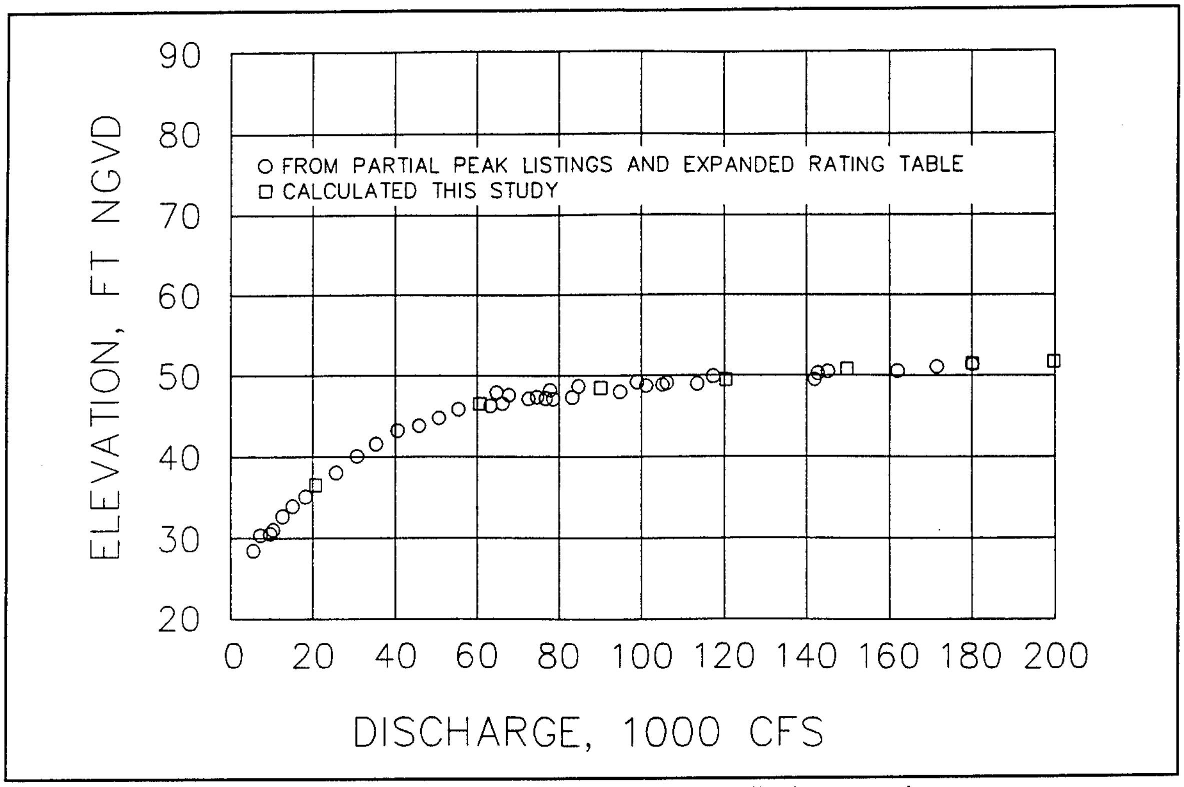

Figure 36. Comparison of measured and calculated stage-discharge rating curves, Apalachicola River near Blountstown

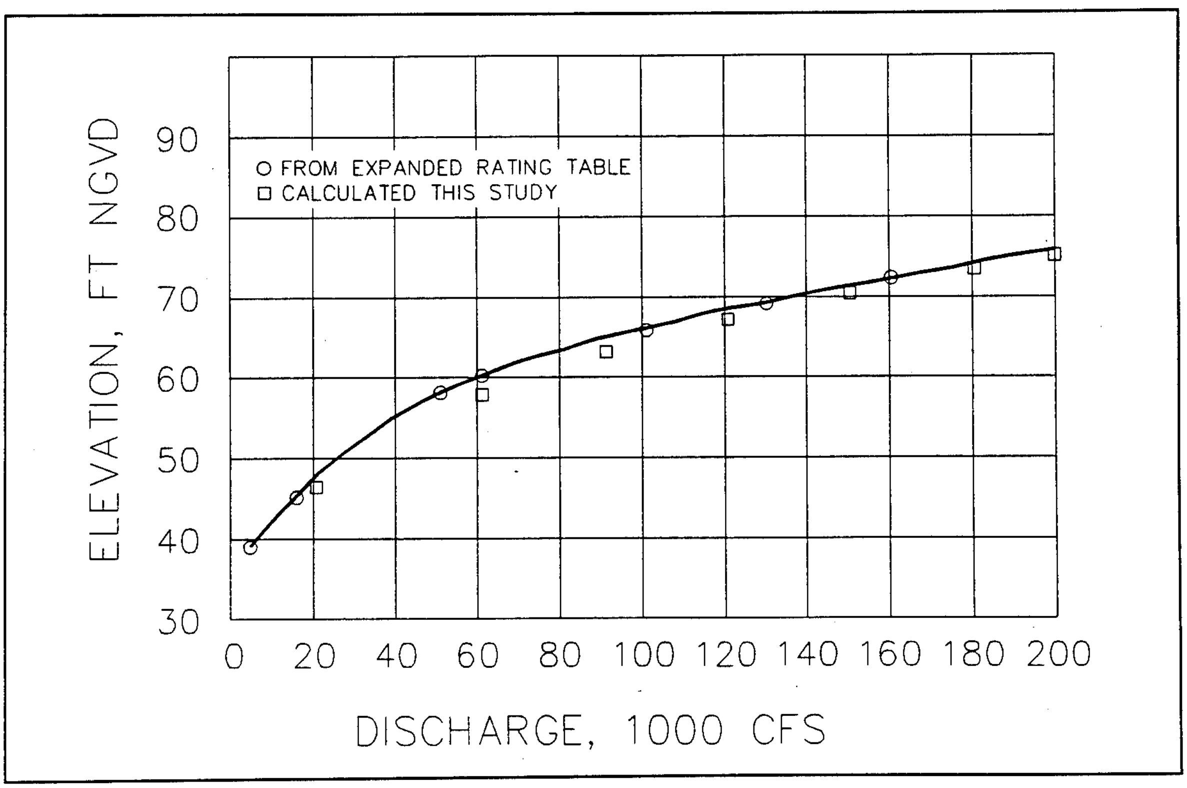

Figure 37. Comparison of measured and calculated stage-discharge rating curves, Apalachicola River at Chattahoochee

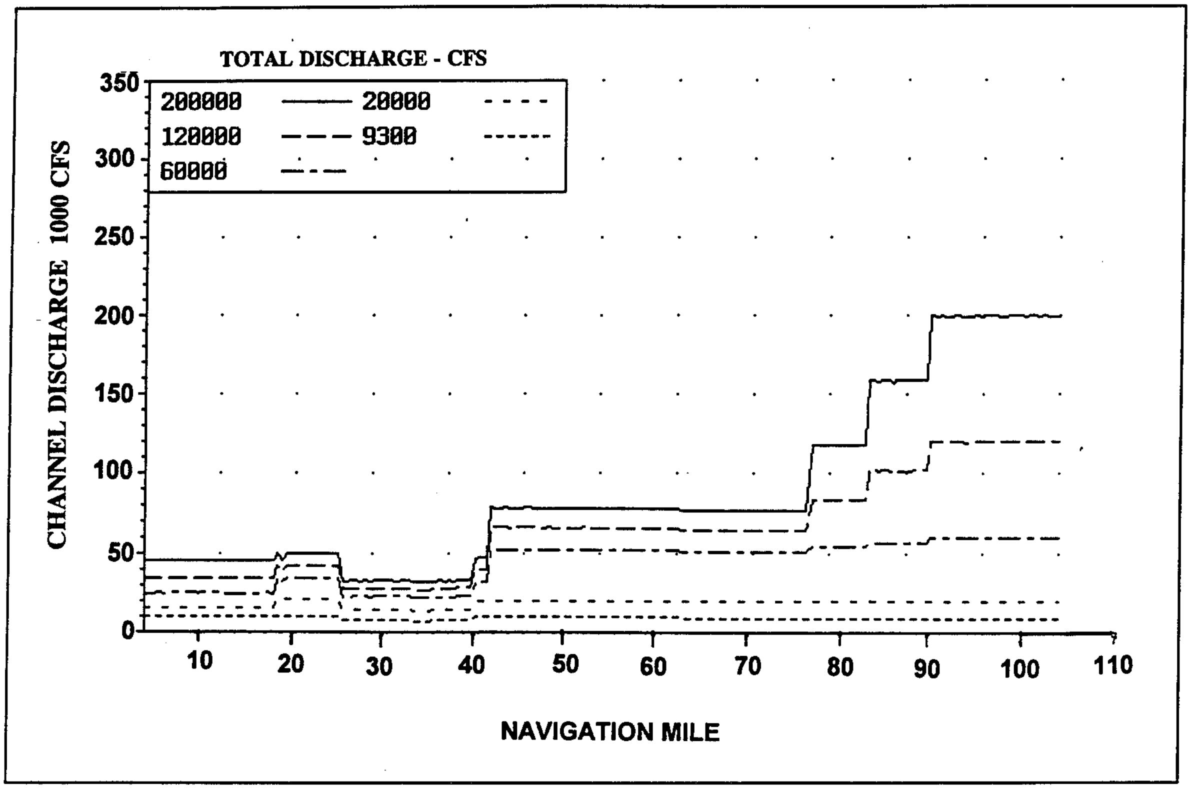

Figure 38. Channel discharges used in the HEC-2 model, Apalachicola River

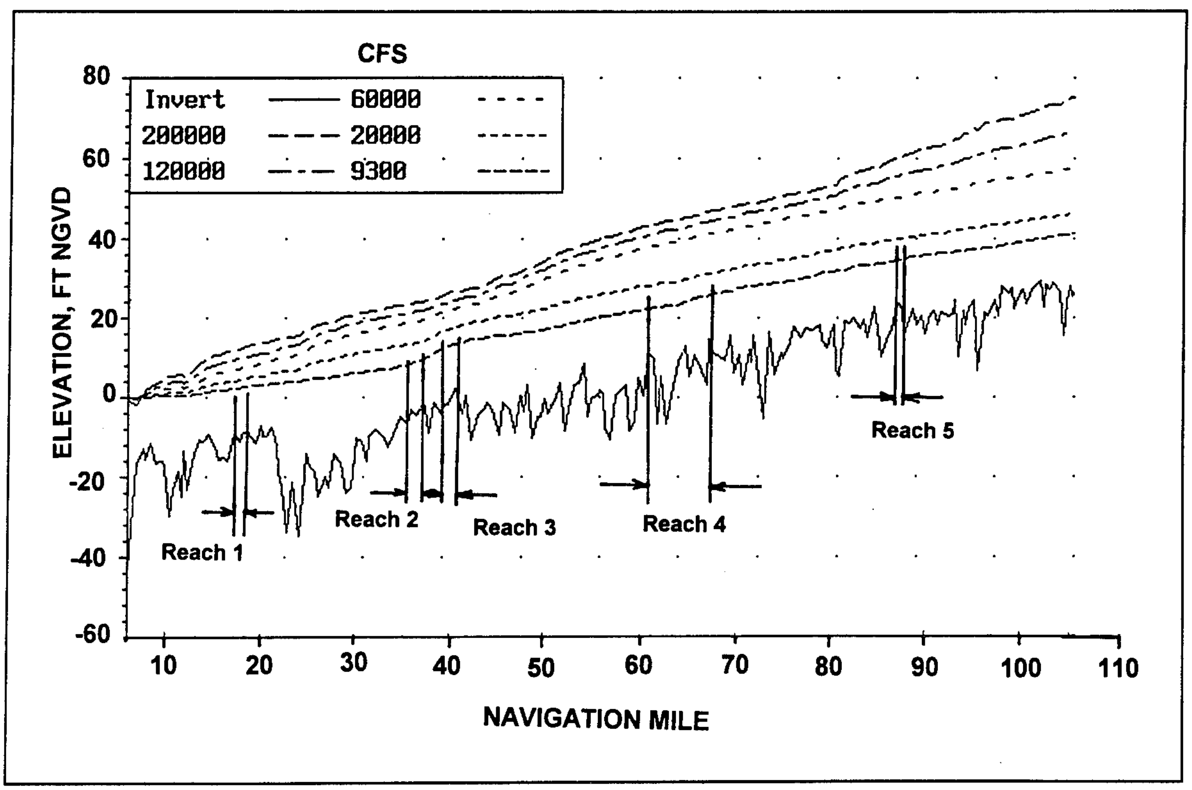

Figure 39. Location of study reaches shown with water surface elevations and thalweg, Apalachicola River

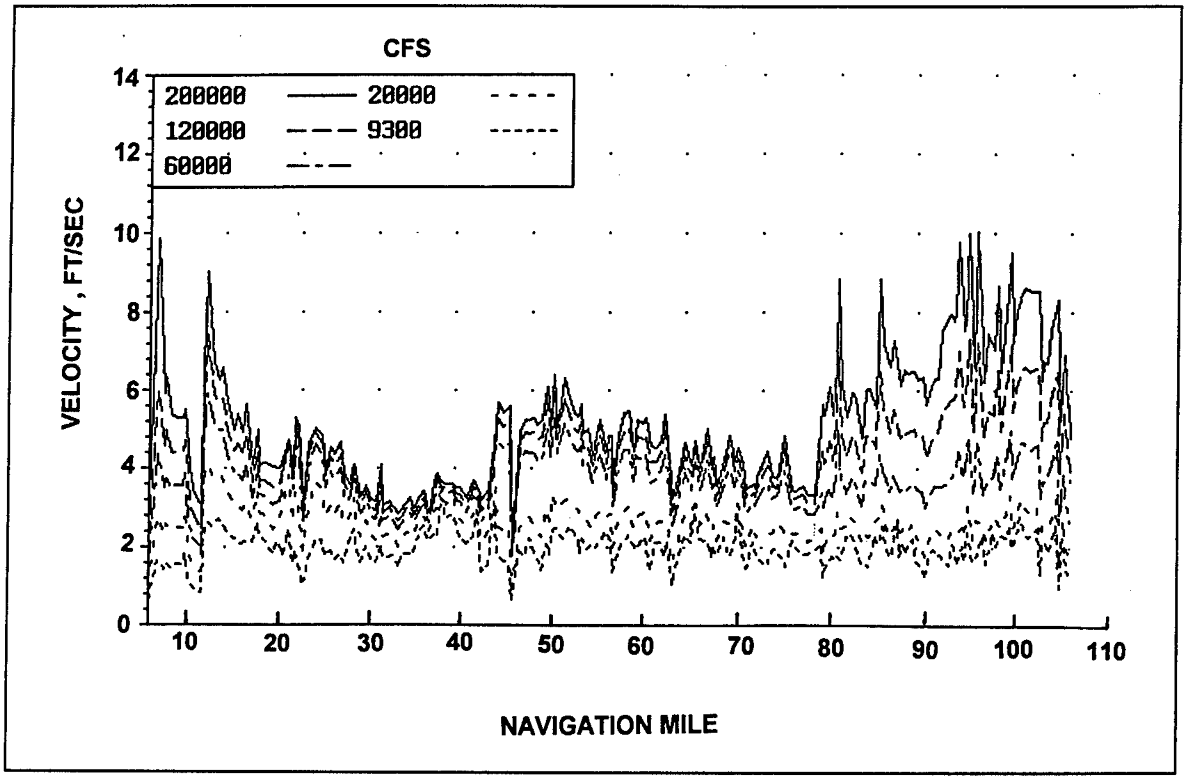

Figure 40. Calculated channel velocities for the 9,300 cfs minimum low-flow channel, Apalachicola River

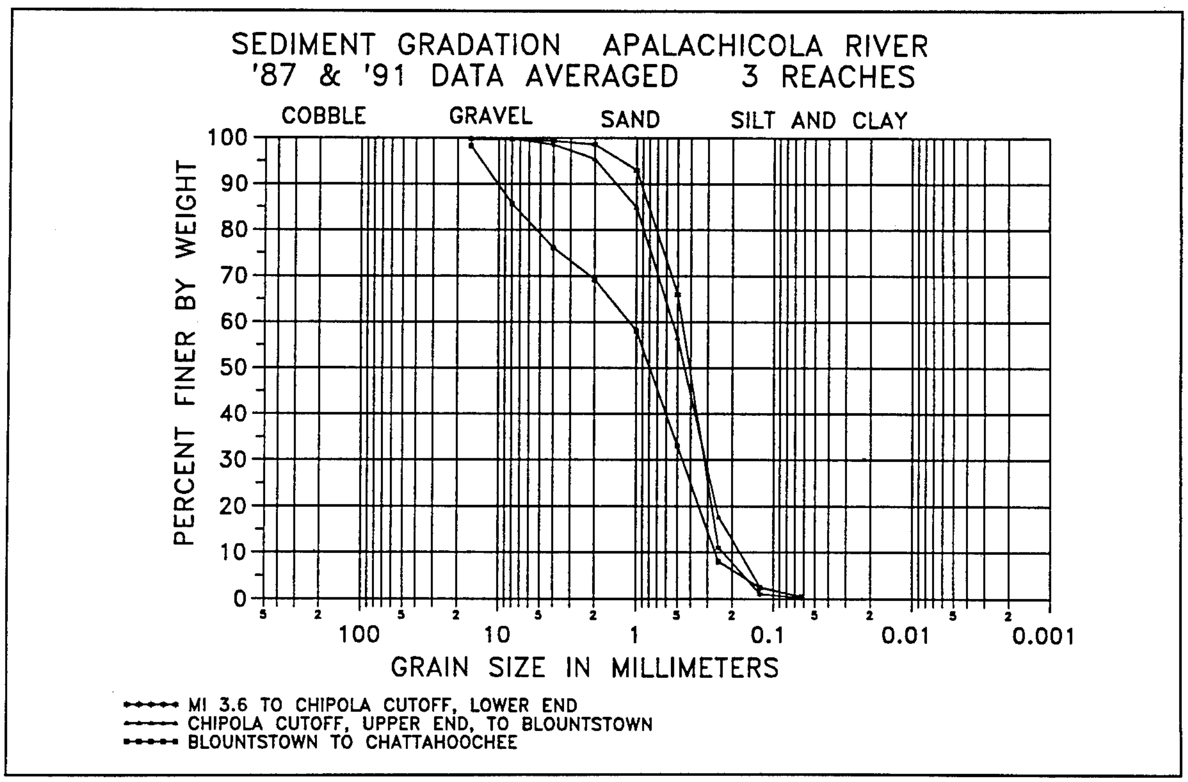

Figure 41. Average measured sediment gradations for the three study reaches, Apalachicola River

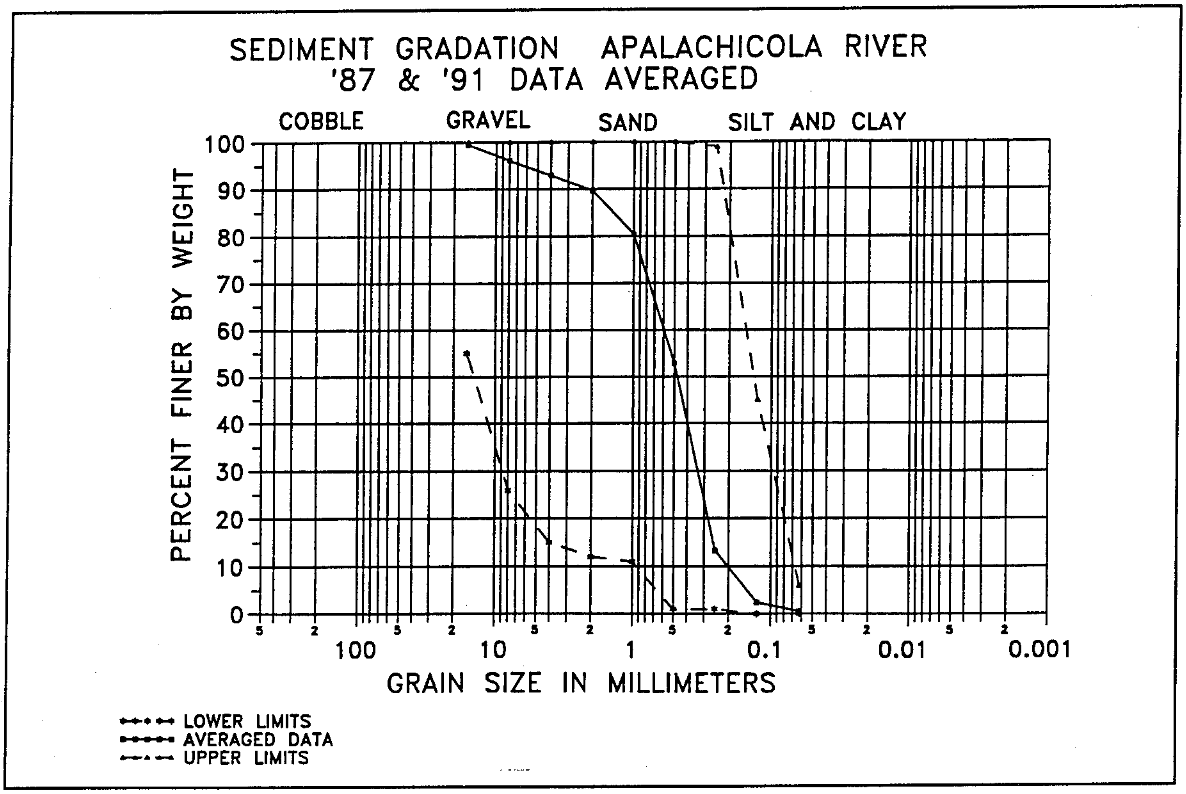

Figure 42. Average sediment gradation and envelope of measured data, Apalachicola River

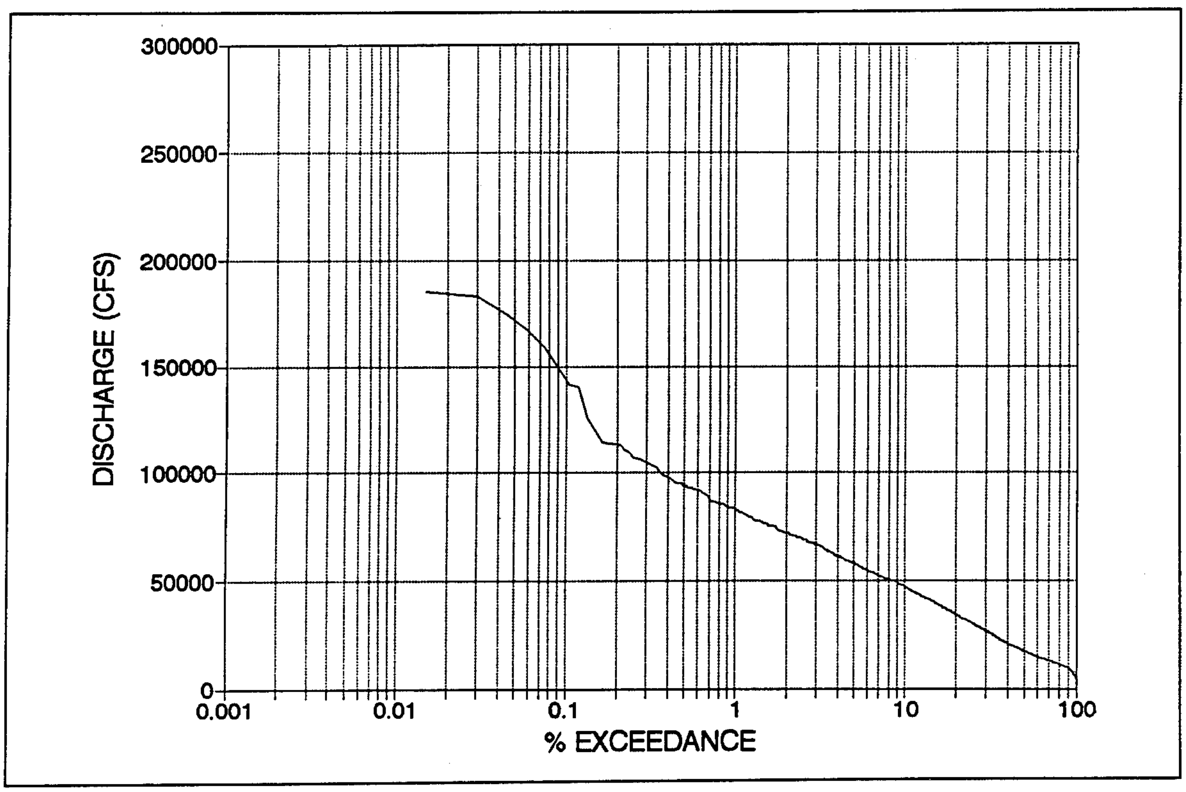

Figure 43. Flow duration curve for Apalachicola River near Blountstown, 1974 to 1993

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12b.DISTRIBUTION CODE

13.ABSTRACT *(Maximum 200 words)*

A sediment impact assessment was conducted for the Alabama River, Alabama, and the Apalachicola River, Florida, as part of a reconnaissance level planning study. Each river is facing proposed navigation channel design changes due to proposed changes in the minimum release from upstream dams. The purpose of the study was to identify the magnitude of differences in sediment transport capacity that might be associated with those changes. The study employed the sediment budget approach to assess channel stability in the study reaches. Average annual flow duration curves were numerically integrated with the calculated sediment transport rating curves to calculate average annual sediment transport capacity for each plan in each of the designated reaches. Relative differences in sediment transport capacity provide an indicator to relative differences in rates of deposition. More detailed sediment studies were recommended.

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